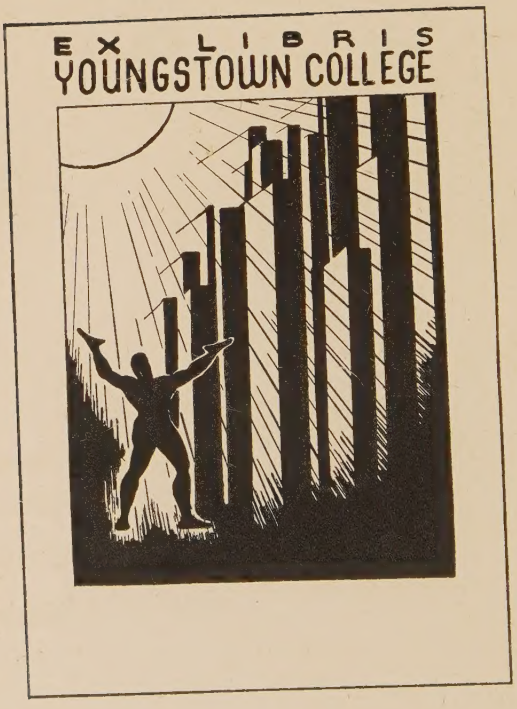

EX LIBRIS
YOUNGSTOWN COLLEGE

Digitized by the Internet Archive
in 2024

https://archive.org/details/publichealthhygi0000unse

Hermann M. Biggs.

PUBLIC HEALTH AND HYGIENE

A STUDENTS' MANUAL

By

CHARLES FREDERICK BOLDUAN, M.D.

Director, Bureau of Health Education, Department of Health, City of New York; Surgeon (R) U. S. Public Health Service; Formerly Lecturer, Preventive Medicine and Public Health, College of Physicians and Surgeons, Columbia University, New York

and

NILS WILLIAM BOLDUAN, M.D.

Children's Medical Service, Bellevue Hospital, New York; Medical Director, School Health Service, Scarsdale, N. Y.

WITHDRAWN

THIRD EDITION, REVISED

YOUNGSTOWN COLLEGE LIBRARY

PHILADELPHIA AND LONDON

W. B. SAUNDERS COMPANY

Copyright, 1929 and 1936, by W. B. Saunders Company

Copyright, 1941, by W. B. Saunders Company

Copyright under the International Copyright Union

All Rights Reserved

This book is protected by copyright. No part of it may be duplicated or reproduced in any manner without written permission from the publisher

Reprinted June, 1942, October, 1945, and November, 1946

MADE IN U. S. A.

PRESS OF
W. B. SAUNDERS COMPANY
PHILADELPHIA

425
.B7

DEDICATED TO THE MEMORY
OF A
GREAT TEACHER, INSPIRING LEADER,
WISE AND PROGRESSIVE ADMINISTRATOR,
PIONEER IN THE MODERN PUBLIC HEALTH MOVEMENT
HERMANN MICHAEL BIGGS, M. D., LL. D.
THROUGH WHOSE GENIUS
SCIENTIFIC DISCOVERIES WERE EVER TRANSLATED
INTO
EFFECTIVE ADMINISTRATIVE MEASURES
FOR THE
PREVENTION AND CONTROL OF DISEASE

PREFACE TO THE THIRD EDITION

The new edition of this students' manual has been thoroughly revised to keep it abreast of advances in the field of public health and hygiene. Besides this a considerable amount of new material has been added without materially increasing the size of the volume. This has been accomplished by omitting a number of less important illustrations and some of the statistical tables previously printed in an appendix.

That the manual has supplied a real need is indicated by the gratifying reception accorded to the previous editions and by the large number of instructors who have adopted it as a textbook. In its present form the manual should prove useful to medical students as a review of their regular course of instruction in public health and preventive medicine, and should be of service to college students, graduate nurses, and social service workers and others by giving them a good understanding of the basic facts and principles of this important subject.

It is a pleasure to acknowledge the valuable assistance given by Dr. Samuel Frant, Epidemiologist and Director of the Bureau of Preventable Diseases in the New York City Department of Health, and by other colleagues in that Department.

The authors will welcome comments and criticisms.

C. F. B.
N. W. B.

New York.

CONTENTS

PART I. GENERAL INTRODUCTION

		PAGE
CHAPTER I.	HISTORICAL	1
CHAPTER II.	MICRO-ORGANISMS AND DISEASE	32
CHAPTER III.	THE TRANSMISSION OF COMMUNICABLE DISEASES	44
CHAPTER IV.	LIFE HISTORY OF CERTAIN IMPORTANT INSECTS	49
CHAPTER V.	DISINFECTION	61
CHAPTER VI.	NONCOMMUNICABLE DISEASES AS HEALTH PROBLEMS	65
CHAPTER VII.	PRINCIPLES OF NUTRITION	67
CHAPTER VIII.	SOCIAL AND ECONOMIC FACTORS IN PUBLIC HEALTH	75

PART II. THE MORE IMPORTANT COMMUNICABLE DISEASES

CHAPTER IX.	TUBERCULOSIS	80
CHAPTER X.	TYPHOID FEVER. PARATYPHOID FEVER. UNDULANT FEVER	91
CHAPTER XI.	DYSENTERY AND CHOLERA	100
CHAPTER XII.	DIPHTHERIA	104
CHAPTER XIII.	SEPTIC SORE THROAT. SCARLET FEVER	113
CHAPTER XIV.	PNEUMONIA, INFLUENZA, COMMON COLDS, WHOOPING COUGH, PSITTACOSIS	117
CHAPTER XV.	SEPSIS, ANTHRAX, PLAGUE, TULAREMIA, TETANUS	125
CHAPTER XVI.	THE EXANTHEMATA: SMALLPOX, COWPOX, CHICKENPOX, MEASLES, TYPHUS	132
CHAPTER XVII.	SYPHILIS, GONORRHEA, AND RELATED INFECTIONS	145
CHAPTER XVIII.	MALARIA, YELLOW FEVER, AFRICAN SLEEPING SICKNESS	155
CHAPTER XIX.	IMPORTANT INFECTIOUS DISEASES OF THE CENTRAL NERVOUS SYSTEM: CEREBROSPINAL MENINGITIS, POLIOMYELITIS, ACUTE INFECTIOUS ENCEPHALITIS, LYMPHOCYTIC CHORIOMENINGITIS, RABIES	163
CHAPTER XX.	FOOD POISONING	172
CHAPTER XXI.	HOOKWORM, TRICHINIASIS, FILARIASIS	178

PART III. IMPORTANT NONCOMMUNICABLE DISEASES AND CONDITIONS

PAGE

CHAPTER XXII.—DISORDERS OF NUTRITION: MALNUTRITION, OBESITY, DIABETES MELLITUS, SCURVY, RICKETS, PELLAGRA, BERIBERI 185
CHAPTER XXIII.—OUR CHANGING HEALTH PROBLEMS 191
CHAPTER XXIV.—CHRONIC DISEASES OF LATER LIFE: DIABETES 196
CHAPTER XXV.—CHRONIC DISEASES OF LATER LIFE: CHRONIC HEART DISEASE 202
CHAPTER XXVI.—CHRONIC DISEASES OF LATER LIFE: CANCER .. 205
CHAPTER XXVII.—ENDOCRINE DISTURBANCES 210
CHAPTER XXVIII.—MENTAL DISEASE AND MENTAL DEFICIENCY 215
CHAPTER XXIX.—HAY FEVER AND ALLIED CONDITIONS (ALLERGY) 219
CHAPTER XXX.—ACCIDENTS 223

PART IV. COMMUNITY HYGIENE

CHAPTER XXXI.—WATER SUPPLY 231
CHAPTER XXXII.—SEWAGE DISPOSAL 242
CHAPTER XXXIII.—DISPOSAL OF OFFAL, GARBAGE AND RUBBISH .. 251
CHAPTER XXXIV.—ADMINISTRATIVE CONTROL OF THE MILK SUPPLY 253
CHAPTER XXXV.—FOOD INSPECTION 261
CHAPTER XXXVI.—SUNLIGHT AND ILLUMINATION 266
CHAPTER XXXVII.—AIR AND VENTILATION 268
CHAPTER XXXVIII.—INDUSTRIAL HYGIENE AND OCCUPATIONAL DISEASES 275
CHAPTER XXXIX.—INFANT HYGIENE. CHILD BEARING 281
CHAPTER XL.—SCHOOL MEDICAL INSPECTION 296
CHAPTER XLI.—PUBLIC HEALTH NURSING 300
CHAPTER XLII.—HEALTH EDUCATION 305

PART V. HEALTH ADMINISTRATION

CHAPTER XLIII.—HEALTH ADMINISTRATION—FEDERAL 308
CHAPTER XLIV.—HEALTH ADMINISTRATION—STATE AND LOCAL 317
CHAPTER XLV.—EPIDEMIOLOGY AND PUBLIC HEALTH 324
CHAPTER XLVI.—THE ENDEMIC INDEX 333
CHAPTER XLVII.—VITAL STATISTICS 339
CHAPTER XLVIII.—PUBLIC HEALTH WORK AN INVESTMENT 353

INDEX 359

PUBLIC HEALTH AND HYGIENE

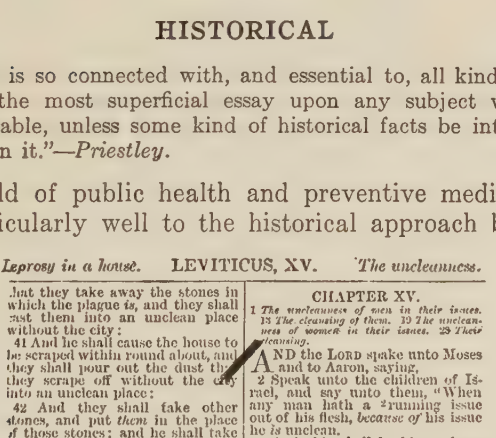
PART I. GENERAL INTRODUCTION

CHAPTER I

HISTORICAL

"History is so connected with, and essential to, all kinds of knowledge, that the most superficial essay upon any subject whatever, is hardly tolerable, unless some kind of historical facts be introduced, or alluded to in it."—*Priestley.*

THE field of public health and preventive medicine lends itself particularly well to the historical approach because of



Leprosy in a house. LEVITICUS, XV. *The uncleanness.*

hat they take away the stones in which the plague *is*, and they shall ast them into an unclean place without the city:

41 And he shall cause the house to be scraped within round about, and they shall pour out the dust that they scrape off without the city into an unclean place:

42 And they shall take other stones, and put *them* in the place of those stones; and he shall take other morter, and shall plaister the house.

43 And if the plague come again, and break out in the house, after that he hath taken away the stones, and after he hath scraped the house, and after it is plastered;

44 Then the priest shall come and look, and, behold, *if* the plague be spread in the house, it *is* a fretting leprosy in the house: it *is* unclean.

45 And he shall break down the house, the stones of it, and the timber thereof, and all the morter of the house; and he shall carry *them* forth out of the city into an unclean place.

46 Moreover he that goeth into the house all the while that it is shut up shall be unclean until the even.

47 And he that lieth in the house

CHAPTER XV.

1 *The uncleanness of men in their issues.* 13 *The cleansing of them.* 19 *The uncleanness of women in their issues.* 25 *Their cleansing.*

AND the LORD spake unto Moses and to Aaron, saying,

2 Speak unto the children of Israel, and say unto them, "When any man hath a [2]running issue out of his flesh, *because of* his issue he *is* unclean.

3 And this shall be his uncleanness in his issue: whether his flesh run with his issue, or his flesh be stopped from his issue, it *is* his uncleanness.

4 Every bed, whereon he lieth that hath the issue, is unclean: and every [3]thing, whereon he sitteth, shall be unclean.

5 And whosoever toucheth his bed shall wash his clothes, *b*and bathe *himself* in water, and be unclean until the even.

6 And he that sitteth on *any* thing whereon he sat that hath the issue shall wash his clothes, and bathe *himself* in water, and be unclean until the even.

7 And he that toucheth the flesh of him that hath the issue shall wash his clothes, and bathe *himself* in water, and be unclean until the even.

8 And if he that hath the issue

Fig. 1.—Preventive medicine among the ancient Hebrews.

its youth. As a scientific discipline and "social science," it exists as such barely a century. Its roots, however, extend far

into antiquity. To attain an understanding of this field in the simplest and most logical way, a knowledge of its chronological development is most desirable.

As is frequently, but by no means always the case, the method of trial and error, as practiced by the common folk, appears to have been the first used in coping with the problems presented by the protection of the people's health. The nomadic wanderings of the Jewish tribes in Biblical times presented just such problems to their leaders. How well the empirical method worked in the hands of the prophets is seen in the sound doctrines of the Mosaic laws, in which specific regulations are promulgated concerning infected excretions and secretions ("issues"), the rôle of camp sanitation, leprosy, food to be eaten, etc. Not the least important contribution to the field of hygiene by this folk is the introduction of a full day of rest after every six days of labor. The well-known rule prohibiting the use of pork is directly implicated in the people's health when we consider that trichinosis, a parasitic infection of the muscles, is traceable to the ingestion of raw pork. We take leave of the Bible pointing out that in that document is also to be found the first recorded census. In a subsequent chapter we shall see how necessary a population census is in formulating an effective public health program.

HIPPOCRATES

Somewhat later than the Hebrews in the history of western civilization, the foundations of medicine were laid in Greece. It should be pointed out that the development of public health is more or less intimately associated with the growth of the science of medicine; hence we must seek in that growth the seeds of our own field. While Greek law and custom laid no great stress on public health rules, Hippocrates (460–377 B.C.), the "Father of Medicine," wrote a treatise on "Airs, Waters and Places," which gave consideration to the influence of environment on health. The Greek conceptions of the causes of disease, while logical and ingenious, were largely based on what we now know to be false premises, and as a result any attempt at *preventive** medicine was bound to be

* Preventive medicine aims to remove or alter the responsible causative factors in order to control or eradicate disease.

well nigh futile. Since these conceptions held sway for many centuries, even up to the end of the Middle Ages in Europe, it is easily understood why the scientific development of this field did not begin until a true knowledge of the causes of disease was attained through the science of bacteriology. To the Greeks, however, we do owe the ideal of a sound body, to be attained through proper physical training. With them we also find the germ of the hospital idea, albeit in a somewhat inchoate form. The ideal form of a Greek sanatorium was that of the Aesculapieion at Cos (Hippocrates), which was

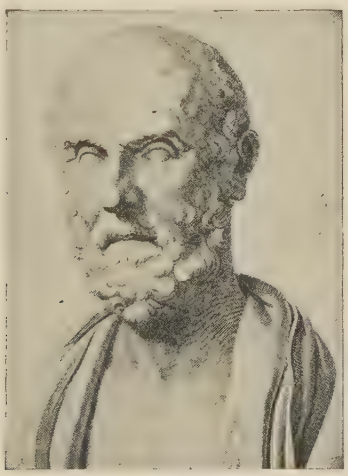


Fig. 2.—Hippocrates (460–377 B.C.).

situated and constructed with strict attention to suitable location, water supply, and proper air and ventilation.

ROMAN EMPIRE

Subsequently, with the mechanically-minded Roman civilization, one branch of public health activity, namely, sanitary engineering, took great forward steps. Here again we see the operation of the empirical method in the development of a field by the laity. Vitruvius, one of the great Roman architects and engineers, writing about 25 to 20 B.C. during the reign of Augustus, laid great stress on the abundance and purity of

the water supply for a community. Gibbon says of the Roman aqueducts: "The boldness of the enterprise, the solidity of the execution, and the uses to which they were subservient rank the aqueducts among the noblest monuments of Roman genius and power." Rome itself boasted of an immense stone aqueduct which brought water to the city from the hills some 25 miles away. This was only one of several. The aqueducts of the capital claim a just preeminence. But even today the curious traveler can see concrete evidence that the solitudes of Asia Minor, Africa and Spain were once covered with

Fig. 3.—An old Roman aqueduct, near Segovia, Spain, still in use.

flourishing cities, whose populousness and even whose existence were derived from such artificial supplies of fresh water.

The city of Rome also built a system of sewers by means of which every street in Rome was drained into the Tiber. The largest of these, the "Cloaca Maxima," is still in use and well preserved. At its mouth it is nearly 11 feet wide and 12 feet high. All the larger cities had paved streets and public baths, and some even provided for the periodic removal of refuse. In excavations at the old Roman camps in the outlying colonies, as for instance near Vienna, the military hospitals were found to be constructed along lines almost modern in their sanitary character.

THE MIDDLE AGES

The views and practices of the Roman empire held sway in the western world up to about 200 to 300 A.D. Then progress ceases. "All the splendid and apparently enduring culture of Greece and Rome, both material and intellectual, is destroyed or broken in the flooding barbarian incursions . . . and western Europe sinks into mental sluggishness and darkness. Much survived, hidden and unknown to the west, in close-walled Byzantium, and some escaped to the east, to return again through the good offices of Arab scholars." "The conditions of the towns were immeasurably inferior to those of the Roman Empire; in the country they can only be described as semi-barbaric. . . . The growth of large towns at a time when the merest rudiments of sanitary science were unknown, and when medical skill was synonymous with superstitious quackery, was a fruitful source of devastating disease." *

During the Middle Ages, as a result of the vast mobilization of nations in the Crusades, leprosy became widespread in Europe. Sporadic cases had undoubtedly occurred along the Atlantic and Mediterranean coasts of Spain and France even before the Christian Era, and in the fifth and sixth centuries its increase in southern and western France aroused serious alarm among the inhabitants. The clergy, concerned for the safety of their flocks, and calling to mind the ancient duties of the priesthood, adopted restrictive measures against lepers. The earliest of these were proposed by the concilium at Lyons (583). An edict promulgated in 644 by Rothari, King of the Longobardi, prescribed the isolation of lepers. In the course of the next few centuries a rigorous system for the control of leprosy was developed to the minutest detail. Every possibility was guarded against in order to avoid direct or indirect contact with lepers, including even their breath. Those afflicted with leprosy were required to warn others of their presence by calling "unclean," or by blowing a horn. By the twelfth century isolation camps were to be found in nearly all parts of Europe. Detailed instructions were given to physicians in order to enable them to diagnose a case, but once an individual was officially pronounced a leper, the poor unfor-

* S. G. B. Stubbs and E. W. Bligh: "Sixty Centuries of Health and Physick," Paul B. Hoeber, Inc., Publisher.

tunate was treated as an outcast and regarded as civilly dead. The enforcement of this segregation was merciless, and continued through several centuries. It was, however, successful, and well nigh eradicated leprosy from Europe. For this reason it deserves to be regarded as one of the first great victories in the field of preventive medicine.

It is certain that the experience gained in dealing with leprosy influenced medical thought considerably. The idea of "contagion," *i. e.*, of diseases spread by direct contact, had become deeply implanted in the minds of the physicians of the thirteenth century. At first they recognized five "con-

Fig. 4.—A case of leprosy.

tagious" diseases, then eight, then eleven, and finally, thirteen. It may be noted that these included leprosy, influenza, gonorrheal ophthalmia, trachoma, scabies, impetigo, anthrax, diphtheria, erysipelas, typhus (including typhoid), plague and consumption. In the fifteenth century syphilis, as a form of pox, was naturally included.

It is important to bear in mind this growing appreciation of contagion in the spread of certain diseases, for it prepared the way for the next advance in preventive medicine.

Not until the close of the fourteenth century do we again encounter the adoption of measures aimed directly at the

prevention of disease. Century after century Europe had been visited by plagues and pestilences, during some of which as many as one quarter of the people died. In the latter half of the fourteenth and the beginning of the fifteenth centuries a particularly severe pandemic, the "Black Death," raged in Europe. To prevent its spread, Venice, Ragusa, Marseilles and Genoa, the chief maritime commercial cities of the Mediterranean, adopted and enforced a forty days' detention period for all vessels entering their ports (1377–1403). This

Fig. 5.—Leper with horn for warning those approaching. From a German manuscript about 1000 A.D. (From Geschichte der Medizin, by Meyer-Steineg and Sudhoff. Gustav Fischer, Jena, Publisher.)

marks the beginning of modern maritime quarantine methods, the word quarantine being derived from "quadraginta," which means forty.

It is not always easy to determine the exact nature of the various epidemics which devastated Europe. Plague, smallpox, typhus and influenza undoubtedly constituted the more common pestilences. It is known that very few persons escaped smallpox. It must be remembered, however, that many diseases now recognized clearly as distinct entities were at that time not differentiated. Thus the "pox" undoubtedly included

YOUNGSTOWN COLLEGE
LIBRARY

both smallpox and great pox, the latter being what we now know as syphilis. Typhus and typhoid fever were regarded as one and the same disease and diphtheria and scarlet fever were not distinguished from each other.

With no scientific knowledge of the nature of disease, it is clear that little or no progress could be made in dealing with these epidemics. Moreover, popular belief held that pestilences were visited upon mankind as a punishment by the

Fig. 6.—Diagnosis of leprosy, 1517. (From Geschichte der Medizin, by Meyer-Steineg and Sudhoff. Gustav Fischer, Jena, Publisher.)

Deity and that sickness and disease were the work of evil spirits. Superstitions like these must have produced a general feeling of helplessness and hopelessness. Many physicians still accepted the teachings of the great Greek physician, *Galen* (130–200 A.D.), who assigned two causes to pestilences: first, a great irregularity in the seasons and a consequent pestilential state of the air; second, a vitiated condition of the human body due to corrupt or defective food. It is not surprising,

therefore, that history records many instances of cruelties resulting from the suspicion that pestilences were due to poisoning. For example, in the Black Death of the fourteenth century the Jews were accused of poisoning the wells. In Strassburg alone 2000 were burned alive and in Mayence 18,000 are said to have been put to a cruel death.

While Galen's teachings contained much that was sound, they were organized into so rigid and formal a system that they greatly impeded original observation and independent thought even through the Middle Ages. It required the force

Fig. 7.—Venesection in the sixteenth century. (From Peaks of Medical History, Charles L. Dana. Paul B. Hoeber, Inc., Publisher.)

and intellectual ability of a *Paracelsus* (1491–1541) to liberate medicine from the thraldom of the Galenic tradition. But another important factor must be considered as responsible for the slight progress in medicine during this period, namely, the attitude of church and state toward scientific research. Serious obstacles were placed in the way of the independent thinker. Scientific workers everywhere were subject to surveillance and persecution, and the publication of views at variance with those held by the authorities was extremely dangerous.

During the Middle Ages surgery, such as it was, was in the hands of the barbers. A large part of their work consisted in pulling teeth, cupping and blood-letting, the latter being resorted to for all manner of ills. Physicians hated and despised barbers and would not degrade themselves to do any manual work such as dressing wounds. In Paris in 1505 the barbers were taken under the protection of the medical faculty. They were known at this time as the Guild of Barber Surgeons, and nearly all the medical officers of the French Army were members of the Guild. In London in 1540 the Company of Barber

Fig. 8.—Ambroise Paré (1510–1590).

Surgeons was empowered to take yearly the bodies of four executed felons for purposes of dissection, and attendance at such dissections was made compulsory. Of all the barber surgeons, the one who did most to advance surgery was *Ambroise Paré* (1510–1590). As barber surgeon in the French army Paré did away with boiling oil and red-hot irons to staunch the flow of blood and made use of the ligature, that is, a thread or wire for tying an artery (1552). This constituted a memorable service to surgery since it made possible amputations on a large scale.

Here and there, as one examines medieval writings, he encounters some sound ideas and advice. Venice in 1438 created the Supervisors of the Health of the Land, under whose control came the water supply, the flour mills, and the baking of bread. In the glass factories of Burano, advanced labor legislation was in vogue: six-hour shifts and insurance against unemployment and old age.

In 1513 Peter Fagarola, Master of Arts and Medicine, writes to his sons:

"Remember about the well water of Toulouse. Wherefore boil it, and the same with water of the Garonne, because such waters are bad. Also after you have risen from table wash out your mouth with wine. . . . Don't have fresh pork too often. Salt pork is all right. . . . Don't go to bed on a full stomach, but an hour after the meal. Also unless some urgent necessity prevents, walk about for a bit after a meal, at least around the square."

As we have already pointed out, the germ of the hospital idea is to be found in ancient times—in the Aesculapieia of the Greeks and the Valetudinaria and military hospitals of the Romans—but Christianity and the Middle Ages deserve the credit for the organization of the hospital as we know it. The famous Hôtel Dieu in Paris owed its beginning in 660 to St. Landry, the twenty-eighth bishop of Paris; St. Bartholomew's in London was founded in 1123 by Rahere, a courtier, though a cleric. On the whole, medieval hospitals rarely specialized in the treatment of the sick, but were more for the purpose of affording shelter to the patient until he was well enough to return to work. Physicians and surgeons, insofar as they were attached to hospitals, occupied an unimportant place, certainly none comparable to that they now enjoy.

We have seen how the field of public health had its roots in antiquity and what contributions were made by the Hebrew, the Greek and the Roman civilizations in ancient times. We have seen also that this field lay comparatively barren in the Middle Ages except for the germination of one or two ideas, such as the hospital idea. When we view the background against which these few new ideas arose, when we consider the resistance toward change inherent in the Ages of Faith,

and the mental apathy with which men of originality always have to deal, we can readily understand why progress was so limited.

THE REVIVAL OF LEARNING

Byzantium, also called Constantinople and Istanbul, fell before the onslaught of the Turks in 1453. As a result of this, and as a result of the advance by the Moors in Western Europe, there became known to a greater extent than theretofore the writings of the Arab scholars.

The Arabs, who had turned quickly from fanatical conquest to the higher pursuits of peace, established universities, libraries, hospitals and schools. They translated numerous Greek texts, and it is these translations which, in many cases, constitute the only record we have of the work of some of the great Greek physicians. Among the prominent Arabian physicians we should remember *Rhazes,* who lived about 900 A.D., as the one who first described measles and smallpox.

With the spread of this body of knowledge, uncolored by ecclesiastical authority, and with the coming of the Renaissance in Italy, the stage is set for a great awakening in the scientific world. There arises the spirit of doubt and inquiry.

The year 1450 is a well-known milestone in the history of human progress. While some authorities put this milestone back to about 1400, and others push it forward to about 1500, by and large we may find between these years evidence of the rebirth of knowledge in all fields of human endeavor.

Italy is generally acknowledged to be the cradle of the Renaissance. There it was that the student as well as the teacher traveled from city to city in search of learning. This spirit of searching is something new, or rather it is a revival of an old heritage of the human race. It was more or less stifled in the Ages of Darkness. Now men not only search for new knowledge but travel afar to obtain it. It is significant that the voyages of exploration by Columbus, Vasco da Gama and many others should fall in this period. "The incursion of foreign influences and the enormous expansion of commerce between Europe and Asia were in effect the prelude to the destruction of the system of the Middle Ages, which, with the powerful intellectual forces of the Renais-

sance, inaugurated the Modern Period."* Many of the explorers and merchantmen came from the northern part of Italy, Columbus himself from Genoa.

In this part of the world there arose at the universities men with the seeking mind. An outstanding example of this group is seen in *Girolamo Fracastor* (1483–1553) who first opened man's eyes to contagion. In 1546 he published a work in Venice, "De contagione," in which he promulgated the idea that certain diseases were spread by "seeds." The three varieties of infection recognized in this genuinely scientific

Fig. 9.—Girolamo Fracastor (1483–1553).

work are: (1) infection by contact, (2) infection by indirect means, as by a garment or fomites, (3) infection at a distance. More than three centuries before modern bacteriology he states:

"These seeds are the carriers of the contagion and that they are the first origin of the disease there can be no doubt. It may be considered that the force of the disease lies in these seeds, since they have the power to propagate and reproduce their own kind."

*S. G. B. Stubbs and E. W. Bligh: "Sixty Centuries of Health and Physick," Paul B. Hoeber, Inc., Publisher.

Conditions in his time undoubtedly helped Fracastor by providing him ample material for study. He saw several waves of epidemic diseases, among them the venereal disease syphilis. Syphilis was first recognized in Italy about 1494, and is thought by some authorities to have been brought to Europe by the sailors of Columbus. Fracastor studied this disease and produced a remarkable poetic work, "Syphilis, sive morbus gallicus." It gave the disease the name which it

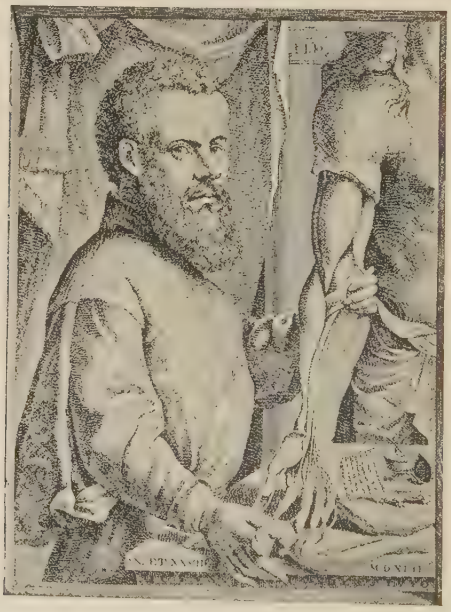


Fig. 10.—Andreas Vesalius, 1514–1564. (Garrison.)

still bears, it described the symptoms accurately and insisted on the virtue of mercury as a remedy.

We shall see below how Fracastor's idea of seeds was taken up at a later date in another part of Europe by a draper in Holland. But to return to the northern part of Italy. At Padua (Shakespeare's "fair nursery of arts") a young Dutchman, *Andreas Vesalius*, published in 1543 his "De Fabrica Humani Corporis" and became the true founder of anatomy,

without which basic science modern medicine could not exist. He established a tradition which was later to bear, as one of its blossoms, that well-known English physician William Harvey, the founder of physiology. Somewhat later in Padua than Vesalius was *Sanctorius* (1561–1636) who was Professor of Theoretical Medicine at that renowned university. "The great Galileo was also at the university and it was clearly from Galileo's influence that Sanctorius conceived the idea of applying exact measurement to the hitherto elusive func-

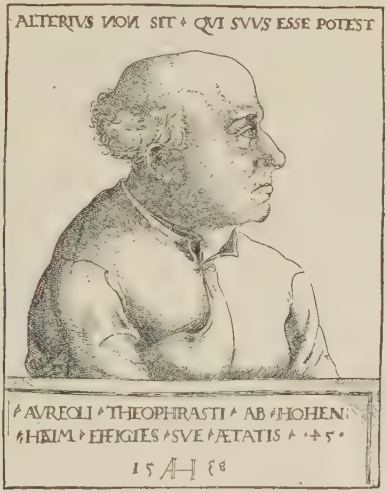


Fig. 11.—Paracelsus in 1538. (From Geschichte der Medizin, by Meyer-Steineg and Sudhoff. Gustav Fischer, Jena, Publisher.)

tions of the body" (Stubbs and Bligh). Sanctorius made a study of his own weight before and after a meal, and under various other conditions and may properly be looked upon as the founder of the science of metabolism and nutrition, the importance of which we have only lately come to realize.

To travel further into the fascinating study of the men of science of this region of Italy would lead us too far afield. Their importance, however, in the progress of public health cannot be overemphasized, for their studies are the bedrock of truth on which modern medicine is built.

Let us turn our attention now from Italy to another part of Europe. Early in the sixteenth century there arose in northern Europe two great reformers—Luther and *Paracelsus*. We may truly say that what Luther was to the spiritual and religious life of his times, Paracelsus was to medicine. Here was a rebel *par excellence*. Illustrative of his character is the incident occurring when he became city physician to Basle in Switzerland. Not only did he lecture in the vernacular (German) instead of in Latin but he began his course of

Fig. 12.—Athanasius Kircher, 1602–1680 (Garrison).

university lectures by publicly burning the works of Galen and Avicenna. It was his spectacular way of breaking the fetters of tradition. He typified another phase of the spirit of his age in being forever on the go, always traveling. While his work was important in the history of medicine, to the student of public health he is noteworthy as one of the first who studied and wrote on industrial diseases. His treatise on miner's diseases, 1567, an original work based on observations in the Tyrol, describes miner's phthisis and the effects

of choke damp. In the same region, near Salzburg, he also observed the close relationship between endemic goiter and cretinism.

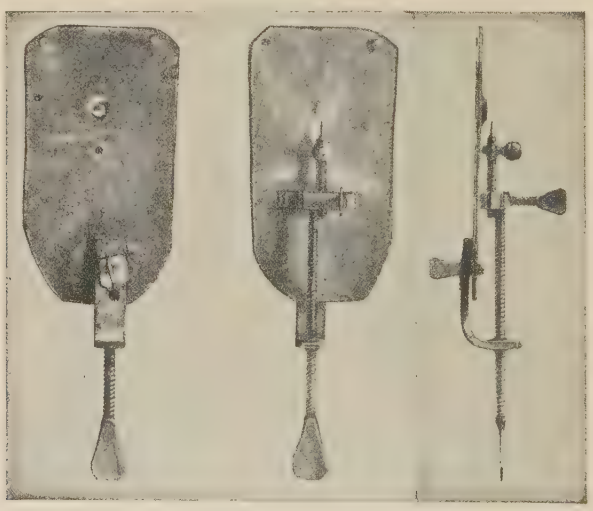
During the latter part of the sixteenth century the center of gravity of the scientific world shifted gradually from Italy northward and westward. In Germany a Jesuit monk *Athanasius Kircher* (1602–1680), mathematician, musician and medical man, was probably the first to employ the microscope in investigating the cause of disease. The most famous of seventeenth century microscopists, however, is a Dutch

Fig. 13.—Antony van Leeuwenhoek (1632–1723).

draper and city hall custodian, *Antony van Leeuwenhoek* (1632–1723), who pursued the study of minute life as a hobby. His fruitful researches into the nature of living matter he communicated in 375 scientific papers to the Royal Society in London. Kircher and Leeuwenhoek were the first to give an observational basis to the remarkable intuitive ideas of Fracastor.

At about the same time that Kircher was active on the continent, and somewhat before Leeuwenhoek, a young Englishman, *William Harvey* (1578–1657), was laying the foun-

dations of modern physiology in England. An heir to the great tradition of Vesalius at Padua, he made use of the discovery by his teacher, Fabricius (1537–1619), of the valves of the veins, in his epoch-making study of the circulation of the blood (De Motu Cordis, 1628). "The crux of Harvey's argument—that the actual quantity and velocity of the blood, as computed by him, make it physically impossible for it to do otherwise than return to the heart by the venous route—was [almost] the first application of the idea of measurement in any biologic investigation. The importance of Harvey's



Figs. 14 and 15.—Leeuwenhoek's microscope: front, back, and side view.

work, then, is not so much the discovery of the circulation of the blood as its quantitative or mathematical demonstration." (Garrison, History of Medicine.)

The first application of mathematical tools to the study of *public health* occurred about the same time, also in England. *John Graunt* in 1662 published the first book on vital statistics (Natural and Political Observations upon the Bills of Mortality) and noted that the population can be estimated from an accurate death rate. The English astronomer, *Edmund Halley,* compiled the Breslau table of births and

funerals (1693) to estimate mortality rates and calculate the expectation of life, and was thus the virtual founder of vital statistics.

In this account of the sixteenth and seventeenth centuries we see how varied and manifold are the branches of human knowledge which made important contributions to the field of public health.

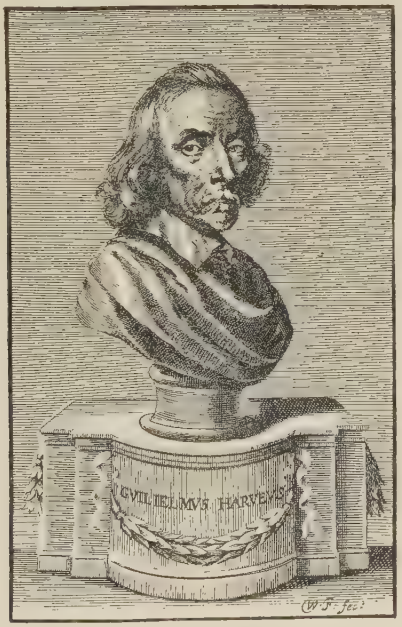


Fig. 16.—William Harvey (1578–1657).

Two great advances in dealing with epidemic diseases made in the seventeenth and eighteenth centuries deserve to be mentioned. The first is the introduction of cinchona bark (Jesuit's bark) as a specific for the treatment of malaria. The other is the control gradually achieved over smallpox.

We have already pointed out how prevalent smallpox was. In the eighteenth century, of which we have the best records, almost everybody had this disease before he grew up and it has been estimated that sixty million people died of smallpox

during that century. In 1717 an Englishwoman, Lady Montagu, while visiting Constantinople, learned of a method of protecting persons against smallpox and immediately wrote to her English friends advocating its adoption. The method consisted in inoculating a healthy individual with some of the matter from the vesicle or pustule of smallpox. This usually resulted in a mild attack of smallpox which made the individual immune. Unfortunately, however, even a mild attack in such an inoculated person may cause a severe attack in

Fig. 17.—Lady Mary Wortley Montagu (1690–1762).

persons coming in contact with the inoculated individual. Hence the method fell into disuse.

We have mentioned the "inoculation" method in order to bring out more clearly the merits of the next great achievement in preventive medicine, namely, the introduction of "vaccination" by Jenner, in 1798. *Jenner,* a physician in Dorsetshire, England, had observed that farmers and dairymaids who had once had cowpox never contracted smallpox. After considerable study and experiment he finally began to transfer material from the pustules of cowpox to healthy children and was able to show that these children were thereafter unable to take smallpox. He called this method of pro-

tection "vaccination" (from the word "vacca," meaning cow). The method, having proved efficacious, spread rapidly and soon led to an enormous reduction in the prevalence of smallpox. In this country, Thomas Jefferson helped materially to

Fig. 18.—Edward Jenner (1749–1823).

spread the new doctrine and wrote to Jenner in enthusiastic praise of his splendid discovery.

GERMS AND DISEASE

Inaugurated by the researches and discoveries of van Leeuwenhoek and Kircher, the question of the origin of germs engaged a large part of the attention of the scientific world in the eighteenth and nineteenth centuries. One school of scientists held that disease germs arose out of filth and decaying matter as a result of spontaneous generation. While this idea (Murchison's filth theory) was later disproved by the epoch-making work of Pasteur and Koch, it served a useful purpose in stimulating community action toward cleanliness.

Louis Pasteur, a French chemist, as a result of careful experimental investigation during the sixties of the last century, showed that fermentation and putrefaction were due to the action of living micro-organisms reproduced from similar pre-existing forms, and that each form of fermentation was due to a special micro-organism. These considerations were applied to the study of disease germs not only by Pasteur and his co-workers, but also by many other investigators. *Robert Koch,* a German country physician, made the most sub-

Fig. 19.—Louis Pasteur (1822–1895).

stantial contributions to this new field of bacteriology by his introduction of solid culture media and by the formulation of four postulates which must be fulfilled before a micro-organism can be regarded as the essential cause of a disease. These postulates are:

1. The specific organism must always be associated with the disease,
2. It must be isolated in pure culture,
3. It must always produce the disease when inoculated into a healthy susceptible animal, and

4. From an animal so infected it must again be obtained in pure culture.

Had it not been for Koch's insistence on this logical chain of proof, it is certain that many micro-organisms would have been regarded as producers of disease to which they were in no way related.

Of the many contemporaries of Pasteur and Koch who did much to win acceptance for the germ theory of disease, mention should be made of *Edwin Klebs,* a pathologist who dis-

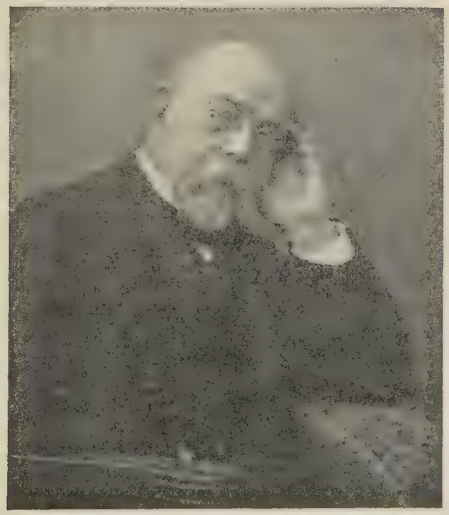


Fig. 20.—Robert Koch (1843–1910).

tinguished himself in many different fields. He was the first to see the typhoid bacillus (1881) and the diphtheria bacillus (1883), the first to inoculate syphilis into monkeys (1878), the first to produce bovine tuberculosis (Perlsucht) by feeding with milk (1873) and the first to experiment with the therapeutic possibilities of the tubercle bacilli of cold-blooded animals.

It was natural, with the epoch-making work by Pasteur and Koch and their pupils, that for some time most of the important scientific discoveries in the field of bacteriology

were made in Europe, especially in Germany and France. Nevertheless, in the practical application of these discoveries to public health administration the United States, or more specifically the New York City Department of Health, soon became the acknowledged leader, thanks to *Hermann M. Biggs* who at that time was the guiding genius of that Department. He it was who in 1892 established the first bacteriologic diagnosis laboratory* as an integral part of a health department, and through a system of collecting stations in drug stores made its diagnostic services readily available to physicians. In 1893 he initiated the program for the administrative control of tuberculosis, making the disease reportable, providing for free sputum examinations by the laboratory, special diagnostic clinics, and sanatoria and hospitals for the treatment of the tuberculous. In 1894 the scope of the Health Department's laboratory activities was broadened to include the manufacture of diphtheria and tetanus antitoxins, this being the first serum laboratory to be established outside of Europe. A few years later research in the field of bacteriology and immunology was undertaken, so that at the turn of the century "Park's laboratory," as it was usually called, had won for itself an international reputation as the outstanding institution for the practical application of the results of scientific laboratory research to public health administration.

Mention should also be made of such distinguished pioneers as Sternberg, Sedgwick, Prudden, Welch, Vaughan, Chapin, Carter, Rosenau, McCoy, Flexner and Ravenel who did much to place American public health practice on a secure, scientific foundation.

Now let us go back for a moment to one of the earliest practical applications of the discoveries in bacteriology. Impressed by Pasteur's studies on fermentation, *Lister* in Great Britain in 1867 devised his "antiseptic" method of surgical operation and the treatment of wounds. By this he sought to kill the germs that might gain access to the wound at the time of operation and at subsequent dressings. By the introduction of this method surgery became *safe*. It had already been made

* Dr. William H. Park was the director of the laboratory from 1893 until his death in 1939.

painless by the introduction of anesthesia. Credit for first using an anesthetic for surgical operations goes to *Dr. Crawford W. Long* of Georgia, who in 1842 removed a small cystic tumor from the back of the neck of a patient under the influ-

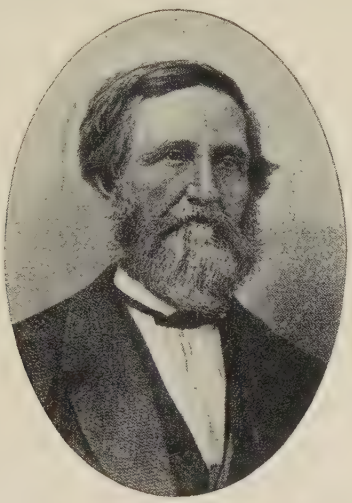


Fig. 21.—Dr. Crawford W. Long.

Fig. 22.—The first operation under anesthesia by Dr. John Collins Warren at the Massachusetts General Hospital, 1846.

ence of ether. In 1844, Horace Wells, a dentist of Hartford, began to use nitrous oxide in dentistry, communicating his results to his friend and former partner, *William T. Morton.* The latter, learning that ether was also an anesthetic, and without previous knowledge of Long's work, used ether in dentistry and subsequently prevailed upon *Dr. John Collins Warren* to give ether anesthesia a trial in a surgical operation. It was this operation at the Massachusetts General Hospital on October 16, 1846, which really gave publicity to anesthesia in surgery.

PROGRESS IN OTHER FIELDS

With the Industrial Revolution which began with the introduction of the steam engine and which brought with it urbani-

Fig. 23.—Florence Nightingale (1820–1910).

zation and overcrowding, there arose many new problems for the student of public health. At the same time there were given into his hands the means by which to deal with them. Industrial diseases (see Paracelsus and Murano) attained a much greater importance than theretofore. It is true that Ramazzini in 1700 wrote a treatise on the disease of tradesmen, in which he makes a "tour from shop to shop, from trade

to trade, making wise and picturesque remarks about the ill effects that each trade has upon its devotees. After reading this, one begins to feel it is really better to be idle. Trade means discomfort, disease, and sometimes death."* But as with so many original observations this came long before its proper time to be fruitful. The political atmosphere of democracy and the concept that government has a responsibility toward the governed had to precede any real advances in labor legislation, without which no progress in combating industrial diseases could be made. These changes in political concepts began during the eighteenth and nineteenth centuries.

Fig. 24.—Sir Edwin Chadwick, 1800–1890. (Garrison.)

The humanitarian ideals were translated into concrete form by the work of Tuke (care of the insane), Florence Nightingale (hospital reform), Chadwick and Simon in England and Eaton and Shattuck in the United States (sanitary reform). While some enlightened public bodies had taken earlier advantage of the increasing opportunities and knowledge, it was not until 1866 (Sanitary Act) that regular and specific hygienic responsibility was thrown upon local authorities throughout England.

*S. G. B. Stubbs and E. W. Bligh: "Sixty Centuries of Health and Physick," Paul B. Hoeber, Inc., Publisher.

In the United States an act framed by Dorman B. Eaton giving vast but necessary powers to the Board of Health of New York City was passed by the state legislature in 1865, largely through the tireless work of Dr. Stephen Smith. This act may be said to mark the beginning of effective health administration in the United States.

The progress made along these lines was slow, and many obstacles had to be overcome. One of the reasons for the slowness of change was the lack of public knowledge and public sympathy with the objects and actions of the pioneers. "It is as impossible to make a people healthy by order as it is to make them moral. They can only be made one or the other by educated consent. While they are ignorant of sanitary principles they cannot but be impatient with the reforming zeal that is urged to disturb their ancient fetid comfort."*

The conditions so admirably described in the preceding paragraph held true to a greater or less extent throughout the "civilized" world. To combat the deadening weight of ignorance, the field of public health education began to develop.

As we have mentioned above, the Industrial Revolution brought with it many new problems. At the same time, the material means for widespread sanitary improvements were created, so that especially in the latter half of the nineteenth century we find the rapid growth of the science of sanitary engineering. The men active in this field devoted their main energy to the creation of safe and sanitary systems of water supply and sewage disposal.

In order that the various agencies dealing with the public health might know not only the magnitude but also the real character and the distribution in time and space of disease, the sciences of vital statistics and epidemiology were drawn upon. Finding their inception with Graunt and Halley, developed further by William Farr, Sir Arthur Newsholme and others, statistical methods have become an invaluable tool in the hands of the public health authorities. The introduction about 1900 of the "International List of Causes of Death" deserves to be mentioned as a milestone in this field, as it

*S. G. B. Stubbs and E. W. Bligh: "Sixty Centuries of Health and Physick," Paul B. Hoeber, Inc., Publisher.

brought about a comparability of achievement, as measured in vital statistics, throughout the civilized world.

At the close of the nineteenth century medical science had discovered the causative micro-organisms of many prevalent diseases and had made considerable progress toward their control. However, there were such diseases as scurvy, rickets, goiter, pellagra and beriberi, for which no causative organism could be found. In this problem, the application of preventive methods awaited the newer developments in the science of nutrition, the discovery of the vitamins, and of the importance of certain substances, organic and inorganic, in our food. While isolated empirical observations, such as those of Lind (1747) on scurvy, and of Paracelsus on cretinism had been made in the previous centuries, it remained for the investigators of the latter half of the nineteenth century and the early part of the twentieth century to find the causes of this group of diseases.

RETROSPECT

As we look back over the development of public health and hygiene during the past century or so it is possible to recognize a number of periods, each with a dominating idea. Thus, as has already been said, the first sixty years of the nineteenth century constitute a period devoted mainly to the sanitation of environment.

Under the leadership of Pasteur, Koch and their pupils, there then came the next great period, the bacteriological era, which dominated public health and hygiene from the early eighties well into the present century.

Closely related, and perhaps to be considered a part of the bacteriologic era, there began early in the nineties a period dominated by extravagant hopes for conquering disease by the use of serums and vaccines. Like its various predecessors it also was able to point to outstanding achievements, but as time went on the hopes for a panacea vanished, and the limitations of serums and vaccines in the prevention and treatment of disease became manifest.

In the first decade of the present century, we accordingly find protests against too great emphasis on germs as *the one* cause of infectious diseases and on too great a reliance on the

specific prevention and treatment of disease by serums and vaccines. More and more insistently is consideration demanded for social and economic conditions as additional important causative factors in the occurrence of disease. Grotjahn* may well be considered the pioneer in this field, and the leader of the movement for social hygiene. His textbook, first published in 1912, presented a vast amount of factual material showing the interrelationships between disease on the one hand and social and economic conditions on the other. It should be noted that the term "social hygiene" is here used in its correct and broad sense, and not, as in the present ridiculous usage in the United States, as synonymous with venereal diseases.

In contrast to conditions in Europe, the past forty years have been characterized in the United States by an increasing recognition of the importance of public enlightenment in health matters. New York City was a pioneer in this field, largely through the campaign against tuberculosis initiated by Biggs, and it was the first to organize a special division of health education (1914) as an integral part of the Health Department. Today almost everywhere in this country health education is considered to be one of a health department's important functions.

In the United States we seem recently to have entered upon another era, one marked by a great change in our previous conceptions of the functions of the Federal government in health matters. By a broader interpretation of the "general welfare" clause of the Constitution, Federal legislation has been enacted providing for grants-in-aid to States for the purpose of improving their health services. Other legislation has provided for the building of hospitals in communities unable to provide such needed facilities. Legislation has also been initiated looking to the provision of medical care by means of sickness insurance for those in the low income groups. While the Acts which provide for Federal grants-in-aid for various health services have found quite general acceptance, some of the plans to provide "adequate medical care" have encountered considerable opposition from the

* Grotjahn, A.: "Soziale Pathologie," Berlin, 1912. Third edition, 1923.

medical profession. Among these is the proposal to place the supervision of the official agencies dealing with the care of the sick, *i. e.*, the public hospital and clinic services, under the State health departments, a responsibility for which, the critics assert, they are not fitted and whose addition would have a detrimental effect on the proper, preventive activities of the health department. Another point of opposition is the proposal for "health insurance," the medical profession fearing that, in the form thus far proposed, this would seriously impede medical progress and lower the standards of medical service. These views have been well presented by Haven Emerson* in recent articles in various medical journals. The problem is beset with difficulties and it will not be solved satisfactorily until the framers of this Federal legislation enlist the confidence and hearty cooperation of the medical profession.

Judging by past experience, we may confidently look forward to the retention of those features of the newer ideas which prove their worth and to the abandonment of others, now extensively propagandized as social panaceas, which further experience may show are of little real value.

In closing this brief historical review the authors would urge the student to acquaint himself with some of the special works on the subject. The following are specially recommended as interesting and delightful reading and reliable as to the facts presented.

A Short History of Medicine, by Charles Singer, M. A., M. D. Clarendon Press, Oxford, 1928.

Medicine in the Middle Ages, by David Riesman, M. D., Sc. D. Paul B. Hoeber, Inc., New York, 1935.

Sixty Centuries of Health and Physick, by S. G. Blaxland Stubbs and E. W. Bligh. Paul B. Hoeber, Inc., New York, 1931.

An invaluable encyclopedic reference book, and delightfully written, is the History of Medicine, by Fielding H. Garrison, A. B., M. D., W. B. Saunders Company, Phila., 4th Ed., 1929.

*Amer. Jour. Pub. Health, Vol. 30, No. 1, Jan., 1940; N. Y. State Jour. Med., Vol. 39, No. 11, June 1, 1939.

CHAPTER II

MICRO-ORGANISMS AND DISEASE

From what has been said in the opening chapter the student will realize that a large proportion of the diseases which we class as preventable are the so-called *infectious* diseases. An infectious disease is one caused by living micro-organisms. Of these we distinguish various broad classes: bacteria, protozoa, fungi, spirochetes, rickettsiae and filtrable viruses.

Bacteria are microscopic one-celled *vegetable* organisms that multiply by transverse fission; protozoa are microscopic one-celled *animal* organisms; fungi are microscopic many-celled vegetable organisms; spirochetes are microscopic organisms formerly regarded as protozoa but now usually classed as belonging among the bacteria, and characterized by a peculiar spiral shape and extreme flexibility; rickettsiae are extremely minute microscopic organisms about which too little is yet known to classify them; the filtrable viruses also are so imperfectly understood that no classification or scientific nomenclature has thus far been possible.

Typhoid fever, diphtheria, tuberculosis and pneumonia are caused by bacteria. Malaria and African sleeping sickness are caused by protozoa. Certain diseases of the hair, scalp and skin are due to fungi. Syphilis and infectious jaundice (Weil's disease) are caused by spirochetes. Typhus fever and Rocky Mountain spotted fever are caused by rickettsiae, and influenza, measles, poliomyelitis and certain diseases of plants are caused by filtrable viruses.

How the various kinds of micro-organisms produce disease is best understood in the case of the bacteria, and it will suffice if the following discussion is limited to this large group. Some bacteria, like the bacillus of diphtheria and the bacillus of tetanus (lockjaw), secrete very powerful poisons, and, while these bacteria do not themselves penetrate deep into the body tissues, their poison is absorbed and gives rise to severe symptoms. In the case of other bacteria, for example, the

tubercle bacillus, the germs penetrate deep into the body tissues and there multiply. In their growth they give off poisons which cause the gradual destruction of the tissues in which they lodge. In this way, for example, the tubercle bacillus destroys lung and bone tissue.

Most germs, for some obscure reason, affect by preference certain parts of the body. The typhoid bacillus usually lodges in the wall of the small intestine; the meningococcus in the lining of the brain and spinal cord; the gonococcus is prone to attack the mucous membrane of the genital organs and the conjunctiva (outer lining of the eye). The pneumococcus affects chiefly the respiratory organs; the diphtheria bacillus the throat and nasal passages.

A characteristic peculiar to infectious diseases (*i. e.*, diseases caused by germs or their products) is the fact that the onset of symptoms occurs only after a definite interval following the introduction of the germ or its products. This is in marked contrast to other forms of poisoning. For example, if a person swallows a poisonous dose of strychnine, the symptoms commence as soon as any considerable quantity of the poison has been absorbed, say within fifteen to thirty minutes. In the case of infectious diseases the interval is always much longer, one or two days is short, and intervals of several weeks are not uncommon. The period between the introduction of the germ or its product and the onset of symptoms is called the *period of incubation.* At one time it was thought to be the time required to "incubate" and develop a sufficient number of germs to cause symptoms, but this simple explanation is now known to be insufficient. Without attempting to go into the more complicated theory furnished by scientific investigations of recent years, one may say, speaking generally, that in any particular disease the shorter the incubation period in a given case, the more virulent is the virus, or the greater the number of invading germs, or, perhaps, the more feeble is the individual.

THE PRODUCTION OF IMMUNITY

It is well known that certain infectious diseases occur naturally only among some of the lower animals, and do not affect man; while, conversely, others appear to attack only

man. Among the latter may be mentioned typhoid fever, syphilis and gonorrhea. In speaking of the resistance evidently possessed by certain individuals or certain species, we make use of the term *natural immunity*. Thus, chickens and frogs possess a natural immunity against tetanus (lockjaw); dogs, a natural immunity against anthrax; goats, a natural immunity against tuberculosis; and man, a natural immunity against certain diseases of cattle. This natural immunity, however, is not absolute. Chickens, for example, can be infected with tetanus if the body is chilled, and frogs can be made susceptible to tetanus by keeping them unduly warm.

Another form of immunity is that observed in individuals who have had one attack of a particular infection; thereafter they are practically safe from a second attack. These individuals are said to possess an *acquired immunity*. This form of immunity is well illustrated in scarlet fever, measles, smallpox and yellow fever. Often this immunity lasts throughout the lifetime of the individual, though there are exceptions.

During the late seventies, Pasteur, in connection with his study of anthrax, conceived the idea of deliberately producing a mild attack of a given infection in order to protect the individual against a serious one, and this could be accomplished by artificially weakening the bacteria with which the original attack of the disease was produced. Subsequently Salmon and Smith, in this country, showed that if dead bacteria were substituted for these weakened living bacteria not even a mild attack of the disease ensued, yet immunity was produced as before.

Acquired immunity, whether caused by a previous natural attack of the disease, or artificially by the inoculation of bacteria, is always *strictly specific*, that is, the protection extends only to the particular disease which has previously occurred or whose germs have previously been injected. An attack of scarlet fever protects only against scarlet fever, but not against measles. Inoculating an individual with typhoid bacilli protects him only against typhoid fever, but not against dysentery, plague or cholera. This acquired immunity is often transmitted from mother to offspring.

Before examining the nature of this very specific form of immunity it will be well to call attention to certain important

means by which the body defends itself against bacterial invasion in general. Many of these are so commonplace that their significance is often overlooked:

1. The protection afforded the body by the *unbroken skin* is undoubtedly one of the most important means of defense. It is well to remember this, and especially to bear in mind that we say "unbroken skin." In the sterilization of the skin prior to a surgical operation much harm is sometimes done by too vigorous scrubbing or by the application of too concentrated disinfectants.

2. A similar protection, though less effective, is that afforded by intact and *healthy mucous membranes*. Any condition injuriously affect-

Fig. 25.—Elie Metchnikoff (1845–1916).

ing these renders the body more susceptible to bacterial invasion. This is well illustrated by the frequency with which an attack of measles (which affects the mucous membranes to a marked degree) is the starting point of other infections.

3. The *acid gastric juice* undoubtedly destroys large numbers of bacteria which are swallowed. Disorders of digestion may, therefore, constitute a deciding factor in determining a bacterial invasion, especially of the intestinal tract.

4. *Fresh blood serum* is able to kill a considerable number of bacteria, and this, therefore, constitutes another mode of defense against bacterial invasion.

5. The white blood cells, or leukocytes as they are called, appear to be designed especially to destroy invading bacteria. These cells take

hold of, or rather engulf, the bacteria and digest them.* This process is spoken of as *phagocytosis*, and was first described by Metchnikoff.

6. Still another mode of defense is seen in what takes place in *abscesses*. When these are examined, it is found that the body has built a wall around the infected area, thus shutting off the bacteria and their poisonous products from the rest of the body.

Returning now to the mechanism of the specific acquired immunity discussed above, we find that, in response to the invasion by pathogenic bacteria or their poisons, the body manufactures certain specific substances seemingly designed to destroy the invaders or to neutralize their poisonous products.

These antagonistic substances are spoken of as *antibodies*. The more important antibodies thus far known are as follows:

1. Antitoxins.
2. Bacteriolysins, hemolysins (cytolysins).
3. Agglutinins.
4. Opsonins.
5. Precipitins.
6. Antiferments.

For our purpose it will suffice to discuss only the first three kinds of antibodies.

Antitoxins.—When an animal is injected with gradually increasing doses of toxin, *e. g.*, with diphtheria toxin, it will be found that after a time the animal withstands doses of the poison which would suffice to kill hundreds of animals not so treated. This experiment was made in 1890 by von Behring, who found that the blood of the treated animals contained something which neutralized the diphtheria poison and rendered it harmless. It was natural to ask whether this blood serum could be used to treat other animals which had been previously injected with diphtheria poison. Von Behring tried it and found that the serum thus used was able to save the animals from death. The action of the substance in the serum which counteracted the effect of the poison was found to be almost like that of an alkali on an acid, *i. e.*, it neutralized the poison. It was, therefore, called an antitoxin, meaning

* Overindulgence in alcohol or exposure to cold make the leukocytes sluggish, so that drunkenness on the part of the individual or exposure to cold often lead to bacterial invasion.

"against toxin." The antitoxic serum from an animal treated with toxin does not differ in appearance from that of a normal untreated animal. Even when tested chemically, but little difference can be discovered between the two. In order, therefore, to recognize the presence of this antitoxin in the serum, and especially in order to measure its amount, we must test it in animals, and see how small a quantity of antitoxic

Fig. 26.—A horse being bled for antitoxin. (Courtesy of H. K. Mulford Co.)

serum will save an animal after it has been injected with a certain amount of diphtheria toxin. For example, when guinea-pigs are used for the test, it is possible that $\frac{1}{1000}$ cc. of the antitoxic serum may be sufficient to save the animal from death, even after it has been injected with 10 fatal doses of the diphtheria toxin. Sometimes, in fact, as little as $\frac{1}{5000}$ cc. suffices. The strength of the antitoxin serum is ex-

pressed in units. In the examples just cited the serum would have a strength of 100 and 500 units per cubic centimeter, respectively.

Bacteriolysins.—Just as an animal when injected with gradually increasing doses of toxin produces an antitoxin in its blood, so also, when injected with bacteria, it manufactures substances which kill and dissolve the injected microorganisms. We have already said that *fresh* blood serum is able to kill a large number of bacteria; however, when an animal is injected with gradually increasing amounts of bacteria, this destructive power increases enormously, though only for the particular kind of bacterium used for injection. Thus, if an animal is injected with cholera vibrios the fresh serum will, after a time, kill an enormous number of these germs, even in very small doses; tested against typhoid bacilli, or any other bacteria, its destructive effect is merely that of a normal serum from an untreated animal. When the action of the serum on the bacteria is studied under the microscope it is seen that the bacteria are actually dissolved. Hence, such a serum is spoken of as a "bacteriolysin," or as being bacteriolytic, which means "bacteria dissolving." Since the bacteria are killed by this action, we also speak of the serum as being "bactericidal," which means "bacteria killing."

It has been found that this action of the serum may be developed against other cells than bacteria. When red blood cells are used for injecting the animal the serum acquires dissolving properties for these, and here, again, the action is strictly specific, so that when blood cells from a chicken are injected into another animal, the serum of the injected animal acquires increased solvent powers only for chicken blood cells, but not for the blood cells of other animals. Instead of using the word "bacteriolysin," we speak of such a serum as a *hemolysin,* or as being "hemolytic," meaning *"blood* dissolving."

The term *cytolysin* is used to embrace all these dissolving sera, "cyto" signifying cell; hence, "cell dissolving."

Investigation showed that the mode of action of these dissolving sera is somewhat complex and requires the joint action of two different constituents. One of these constituents decomposes very easily, so that a serum which has stood sev-

eral days may be found to have lost almost entirely its solvent power. Curiously, however, the addition of a little fresh serum, even from a normal animal, immediately restores its power. This very unstable constituent, which is present in all fresh serum, even in that from normal animals, is spoken of as *complement*, because it completes or complements the action of the other constituent. The stable constituent is called the *immune body*.

When the animal is repeatedly injected with gradually increasing doses of bacteria (or other cells), it responds by manufacturing large quantities of this immune body, directed specifically against the injected bacteria. This substance lays

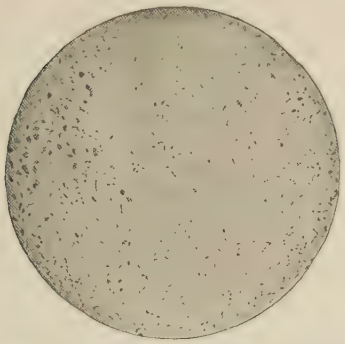


Fig. 27.—Typhoid bacilli unagglutinated (Jordan).

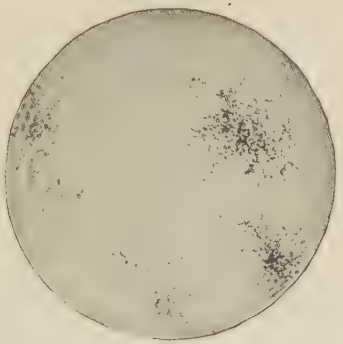


Fig. 28.—Typhoid bacilli, showing typic clumping by typhoid serum (Jordan).

hold of the invading bacteria and, with the aid of the complement, effects the destruction. The complement alone would be unable to destroy the bacteria; the immune body is needed to prepare the bacteria in some way as yet not known.

Agglutinins.—When the serum of an animal which has been repeatedly injected with gradually increasing doses of bacteria is brought into contact with some of these bacteria, careful observation under a microscope reveals a very interesting series of changes. Thus, if typhoid bacilli are mixed with a specific antityphoid serum (obtained, say, from a rabbit previously injected with typhoid bacilli) one notices first that the motility of the bacilli becomes markedly diminished.

This is followed by the gradual collection of the bacilli into clumps. At the end of an hour or two, in place of countless bacteria moving quickly through the field, one sees merely several groups of absolutely immobile bacilli. If the reaction is feeble the clumps are small, and one finds comparatively many isolated and, perhaps, also moving bacteria. This phenomenon is spoken of as "agglutination," and the substance which causes it as "agglutinin." The clumping thus brought about does not kill the bacteria; moreover, it makes no difference whether the serum is freshly drawn or has been kept for some time, it will agglutinate equally well, and does not require the addition of fresh serum as do the bacteriolysins.

Like the antitoxins and bacteriolysins, the agglutinins are strictly specific, *i. e.*, the serum from an animal injected previously with typhoid bacilli will agglutinate only typhoid bacilli; that from an animal injected with meningococci will agglutinate only meningococci, and so on.

Since the agglutinins do not kill the bacteria, it may be asked what their function is. Up to the present time we do not know. Through the studies of Gruber and Widal, however, the agglutinins have come to play a prominent part in the *diagnosis of bacterial infections* and, in what is called the "Widal reaction," afford an important aid in diagnosing typhoid fever. The Widal test in typhoid fever may be performed with blood serum from the patient or, what is still simpler, with a drop of blood collected on a glass slide and allowed to dry. If the latter method is employed, the drop is soaked off with sufficient distilled water to make approximately a dilution of 1 part of blood in 20 parts of the mixture. Next, a loopful of this mixture is mixed with a loopful of a broth culture of typhoid bacilli, and this mixture of diluted blood and typhoid culture is then examined by means of the hanging-drop method under the microscope. If complete agglutination takes place within thirty minutes, one speaks of having obtained a positive Widal reaction. This means that the patient is suffering from typhoid fever, or has recently had the disease (for the serum continues to show the reaction some time after convalescence), or that he has recently been injected with typhoid vaccine.

Agglutination reactions may also be employed in a reverse manner for identifying bacteria. In that case, one employs an agglutinating serum made against a certain bacterium and tests the bacterium being studied. If it agglutinates with this serum, especially when the serum is highly diluted, one argues that it is identical with or at least very closely related to the bacterium used for making the serum.

SERUM AND VACCINE THERAPY

The principles underlying the production of antitoxin have already been described. Injected into a patient suffering from *diphtheria,* the antitoxin at once lays hold of the toxin which the diphtheria bacilli are producing, neutralizes it and quickly restores the patient to health. The great convenience in the use of diphtheria antitoxin lies in the fact that we can get a horse to produce it for us, and subsequently, by bleeding the animal, collecting the serum, and injecting it into man, can promptly confer immunity against diphtheria on the person so injected. We speak of this kind of immunity as *passive* immunity because the patient's body has taken no active part in the production of the protective substance—the antitoxin. It is, of course, plain that the antitoxin can merely ward off from the cells of the body the toxin which is threatening them; the toxin which has already begun to act on the cells cannot be neutralized by the antitoxin. In every case of diphtheria, therefore, it is most important to give the full dose of antitoxin as early as possible, and to give a small dose also to all who have been or expect to be in direct contact with the patient.

In the treatment of *tetanus,* once the disease has begun, the clinical results following the administration of tetanus antitoxin have not been satisfactory. Now and then, to be sure, especially when the antitoxin is given intraspinally, the treatment appears to have been of benefit. Tetanus antitoxin is widely used as a preventive of tetanus, being given after accidental wounds and similar surgical injuries.

Antimeningococcus serum is used in the treatment of *epidemic meningitis,* and this form of treatment has reduced the case fatality to about half that observed in cases treated without serum.

In certain types of *pneumonia*, excellent results are now obtained by a specific antipneumococcus serum directed against the particular type of pneumococcus involved.

So far as the bacteriolysins are concerned, the clinical results have not been very satisfactory. Investigation has disclosed many difficulties which must still be overcome. In speaking of these sera it is better to use the term "antibacterial," because, after all, when we immunize an animal against a certain bacterium we do not produce merely a bacteriolysin, but a serum which contains also agglutinins, precipitins, opsonins and, perhaps, still other antibodies.

Therapeutic Uses of Blood of Human Convalescents.—In view of the fact that specific immune substances (antibodies) are known to be present in the blood of those who have convalesced from infectious disease, it was natural to believe that the blood of such individuals might be used in the immunization and treatment of others, especially in those cases where the causative germ of the disease was not yet known, and where, therefore, there was no possibility of producing immune sera in laboratory animals. As a matter of fact, clinical trials along these lines have yielded encouraging results.

Bacterial Vaccines.—The lack of success attending the use of many of the antibacterial sera has turned attention to treatment of bacterial infections by means of "active immunization." Thus, when we inject a horse with diphtheria *toxin* in order to produce *antitoxin*, we *actively* immunize; when we inject the antitoxin into a child in order to protect the child against diphtheria, we *passively* immunize.

Active immunization with bacteria consists usually in injecting the patient with suspensions of dead bacteria, thus causing the production on his part of the various antibodies already described, and bringing about a condition of immunity. The bacteria are usually grown on agar in the ordinary way and, after being washed off into a test tube containing a little salt solution, are heated for about half an hour to 60° C. in order to kill all the bacteria. Sterility is insured by suitable tests. The suspension is then diluted so that each cubic centimeter will contain exactly a certain number of million bacteria, after which it is ready for injection.

Such a suspension is spoken of as a "bacterial vaccine." The doses of the different vaccines vary. In the case of the staphylococcus vaccine the ordinary dose is from 250,000,000 to 500,000,000. Gonococci are usually given in much smaller doses, namely, from 15,000,000 to 50,000,000. The dose of the typhoid vaccine is from 500,000,000 to 1,000,000,000 and whooping cough vaccine is used in doses of several billion bacilli. The vaccines are usually given in several doses, injections being made from five days to a week apart. A number of investigators have tried giving bacterial vaccines by mouth and have apparently been able to immunize even with this mode of administration. This will be touched upon in speaking of Calmette's method of immunizing infants against tuberculosis.

CHAPTER III

THE TRANSMISSION OF COMMUNICABLE DISEASES

Experience has shown that the most effective means of combating communicable diseases is to prevent their transmission. To achieve this we must, of course, have exact knowledge concerning the occurrence of the causative microorganisms, and the conditions under which transmission occurs.

Up to the end of the nineteenth century the prevailing opinion accepted by both the medical profession and the public at large, was that communicable diseases were commonly transmitted by infected clothing, rags, baggage, money, books and innumerable other articles. These alleged agents were spoken of as *fomites*. As time went on and the various microorganisms of disease were carefully studied, it was found that the rôle played by such infected articles is relatively unimportant, and that communicable diseases are most frequently transmitted by persons rather than by things, by contact with those harboring the infecting agent, by certain discharges of those infected, and by insects and vermin.

It must be remembered that many disease germs die quickly when removed from the body of their host, and that only relatively few germs producing disease in man resist the destructive effect of air (drying) and of sunshine. However, we do know of certain bacteria which are very resistant to destructive influences and, when these are present, transmission through infected objects (fomites) is not uncommon. As an example one may cite the transmission of tetanus and anthrax.

Studies conducted in connection with tuberculosis showed that when a consumptive coughs, fine particles of infected mucus are sprayed into the air. By exposing sterile agar plates at various distances from such a coughing individual it was found that infected spray could be detected in the air several feet away. This observation constitutes the basis of

what is known as the theory of *droplet infection,* a theory now widely accepted in explaining the transmission of certain respiratory diseases, such as tuberculosis, measles, pneumonia, the pneumonic form of plague and influenza. In this connection it must be pointed out that the theory of droplet infection does not necessarily imply that, when a susceptible individual breathes such infected air, the germs enter the system through the lungs. In fact, there is reason to believe that this is usually not the case. The minute droplets of infected mucus are deposited on the mucous membranes of the upper respiratory tract, on the tonsils and in the pharynx, from which locations they probably invade the body by various routes.

A large number of disease germs enter the body through the *alimentary tract.* Examples of the infectious diseases transmitted this way are typhoid fever, septic sore throat, cholera and dysentery. Tuberculosis is probably often transmitted in this way, especially in children, when tubercle bacilli are present in milk from tuberculous cows. In studying infections caused by germs entering through the mouth, one should bear in mind the innumerable ways in which germs find entrance into the food or drink which serves as the vehicle for infection. Thus, in the case of typhoid fever, the feces of a patient suffering from the disease may be deposited on the surface of the ground and be washed by rains into a brook or spring used as drinking water; or they may find their way from a neglected privy into a well. In either case a person drinking the infected water may suffer a *water-borne infection.* Numerous cases are on record in which dairy farmers have washed their milk cans in water which was polluted with typhoid bacilli, with subsequent contamination of the milk. Those who became infected by drinking this milk suffered a *milk-borne infection.* Cases are known in which a convalescent from typhoid fever handled milk and other foods while typhoid bacilli were still present in the stools, and thereby infected this milk and food, and transmitted the disease to others. So, too, dairymen suffering from scarlet fever or from septic sore throat have been known to spread these diseases through handling milk.

There is another form of milk-borne infection, namely, the transmission of a disease affecting the milk-producing animal.

Cows suffering from tuberculosis are very likely to have bovine tubercle bacilli in their milk, and in those suffering from disease of the udder virulent streptococci are apt to be present. In certain countries the milk of goats often contains bacteria causing undulant fever (Malta fever). All these bacteria may produce disease in humans.

In sections of the country where neglected outdoor privies abound, and where no precautions are taken against flies, typhoid bacilli have been carried by flies from exposed excreta to food and drink, and "fly-borne" typhoid infection has resulted. The eating of raw oysters which have been grown or fattened in sewage-polluted waters may serve as a means of transmitting typhoid infection. Still another variety of infection through foods is that caused by such bacteria as paratyphoid bacilli, Bacillus botulinus, B. proteus, or their poisons. This variety is often associated with decomposition in the food, and gives rise to what the laity calls "ptomaine poisoning."

A very common method of transmitting communicable diseases is by the almost *direct transfer* of infectious material from one individual to another by means of common eating and drinking utensils, by the use of common towels, or by the practice among children of sucking the same stick of candy. Kissing is undoubtedly a frequent mode of transmitting infection, especially to infants.

Two diseases, syphilis and gonorrhea, are most often spread from person to person by *sexual relations*, though this is not the only manner in which they are communicated.

Transmission of infectious disease from mother to offspring is common in syphilis, and was formerly believed to occur frequently in tuberculosis. In the latter disease, however, this form of transmission is extremely rare. In mental diseases, however, *hereditary* transmission is common.

A number of communicable diseases are transmitted by the *bites of animals*, particularly insects. It is important to distinguish two forms of transmission. In one the animal acts merely as the mechanical agent for transferring the germ. Examples of this are the transmission of plague by the bite of fleas which have come from plague-infected rats or other rodents, and the transmission of typhus fever by lice. In the

other form, the biting insect constitutes a necessary intermediate host for the infecting germ. Thus, in malaria, the germs sucked up by the mosquito when biting an infected individual cannot at once be transferred to a second person by the bite of this mosquito. A definite interval must elapse, during which the malaria parasite undergoes a number of necessary changes in the body of the mosquito. Not until these are completed, that is, in from ten to fourteen days, can this infected mosquito transmit malaria to another person. Moreover, the necessary changes on the part of the malaria parasite occur only in mosquitoes of the genus *Anopheles*. This second type of transmission holds true also for yellow fever, dengue and African sleeping sickness.

Certain communicable diseases are transmitted by the bites of larger animals. The most familiar of these diseases is rabies, usually transmitted by the bite of a rabid dog. A febrile disease, known as rat-bite fever, and said to be due to infection with a spirochete, is occasionally observed following the bite of a rat.

One of the most important of all factors in the transmission of communicable diseases is the healthy *carrier*. The significance of carriers and the great frequency with which they occur have only recently become adequately appreciated. The term "carrier" is applied to an individual who, while himself healthy, nevertheless harbors disease germs which he may spread to others. In a large proportion of cases it is found that these healthy carriers are individuals who, at one time or another, have had the disease whose germs they carry. It is, therefore, probable that the germs have remained in the carrier's body ever since the attack of the disease. But carriers are often encountered in whom no evidence can be discovered of their ever having suffered an attack of infection with the germs they harbor. It is now well established that a small proportion of normal healthy individuals who come into close contact with persons ill with an infectious disease take the germ of this disease into their system and continue to harbor it there without becoming ill themselves. A higher proportion of healthy carriers is therefore found in those coming into contact with persons ill with an infectious disease than is found in the population at large.

The discovery that carriers spread the germs of a large number of important communicable diseases disclosed entirely new problems in preventive medicine. It was realized that, in devising preventive measures, it did not suffice to confine attention to those who were ill, but that it was extremely important to discover the healthy carriers and try to prevent their spreading the disease. The occurrence of carriers explains, too, why additional cases of some particular infectious disease continue to develop despite rigorous isolation of those who are ill.

In most infections the "carrier" condition is only transitory, lasting perhaps a few weeks. In typhoid fever, on the other hand, the carrier condition often persists for many years, as is well illustrated by the case of a typhoid carrier discovered by the senior author in the course of an extensive milk-borne epidemic of typhoid fever in New York City in 1910. This particular carrier, a dairyman, had had typhoid fever forty-nine years previously. He remained a carrier to his death some five or six years after his carrier condition was discovered. Some individuals remain carriers only a short time. These are spoken of as "temporary carriers." Others, like the one just mentioned, remain carriers for many years and are spoken of as "chronic carriers."

Finally we must also bear in mind that diseases are frequently spread because of the failure to diagnose the original infection correctly. Such mistakes, of course, are more common in mild or atypical cases. Unrecognized cases are spoken of as *missed cases*.

Before closing this chapter a word should be said about the transmission of communicable diseases by way of the *skin*. Ordinarily, the intact skin serves as a sufficient protection against invasion by the germs of communicable diseases. In at least one disease, however, this does not hold true, namely, in hookworm. This disease, to be sure, is not a bacterial infection, but is the result of infection with small worms which fasten themselves on the inner walls of the intestine. The larvae of these worms usually enter the body through the intact skin of the feet and legs, and subsequently find their way into the intestine (see also page 178).

CHAPTER IV

LIFE HISTORY OF CERTAIN IMPORTANT INSECTS

The term "insect" is applied to any of numerous, small invertebrate animals generally having the body more or less obviously segmented. The true insects have only three pairs of legs. Many of them, such as beetles, bugs, bees, flies and mosquitoes, are winged. In popular usage the term insect is applied also to allied animals, usually wingless and often having more than six legs, as spiders, mites, ticks, centipedes and wood lice.

The class Insecta is by far the largest class of animals, exceeding all other land animals together in number of species and individuals. Over 250,000 species are known to science. The majority of insects are vegetable feeders, some forms causing enormous economic losses by their injury to cultivated plants. Others are troublesome parasites of man or of domestic animals, and dangerous as carriers of disease germs. On the other hand, many species are useful in cross-pollination of plants, and a few, as bees and silkworms, produce useful substances.

Mosquitoes.—Among the insect carriers of disease one of the most important is the mosquito. In considering the life history of this insect it will be well to describe first that of the common house mosquito, *Culex pipiens,* because this is the type most familiar to the reader.

After fertilization by the male, the female mosquito lays her eggs upon the surface of some standing water. The eggs are ovoid and usually adhere to one another to form a little raft, the pointed ends down. In from one to three days the eggs hatch into *larvae,* usually called "wigglers," which live in the water and can readily be seen with the naked eye. The larvae come to the surface at intervals to breathe. They do this through a tube which grows from the body near the tail. When disturbed, the larvae wiggle to the bottom of the pool or vessel to hide. During the next week or so they moult

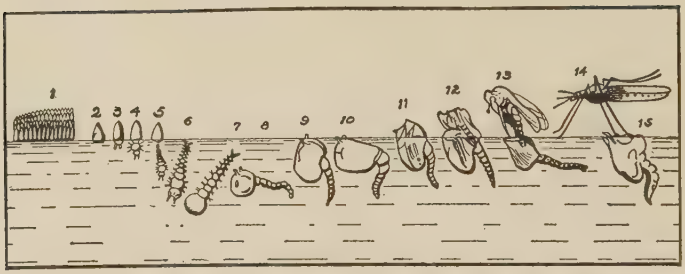
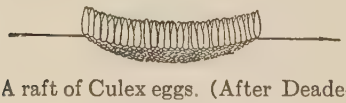
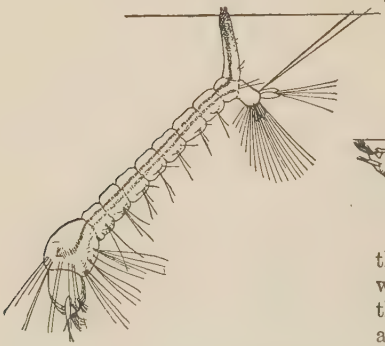


Fig. 29.—Life cycle of mosquito. Chart showing how the common house mosquito breeds: *1,* the eggs, as deposited on the surface of the water; *2,* separating from the mass. The larva, *3, 4,* forming; *5,* emerging, about the thickness of a thread; *6,* breathing through the tail; *7,* changing to pupa. The pupa, *8,* descending from the surface, when disturbed; *9, 10,* breathing; *11, 12,* changing to insect. The complete insect, *13,* emerging; *14,* allowing its wings and body to harden and expand ready for flight, using the pupal skin, *15,* as a float. The eggs and young of the malaria-carrying mosquitoes go through a similar process of development.

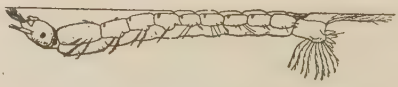


A raft of Culex eggs. (After Deaderick.)

Patterns assumed by Anopheles eggs. (After Deaderick.)



Larva of a Culex. (After Howard.)

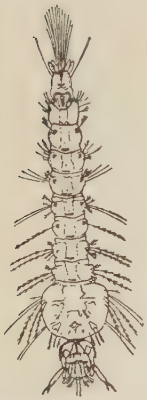


Larva of Anopheles. Contrast the horizontal position in the water with the diagonal position of the Culex larva. (After Castellani and Chalmers.)

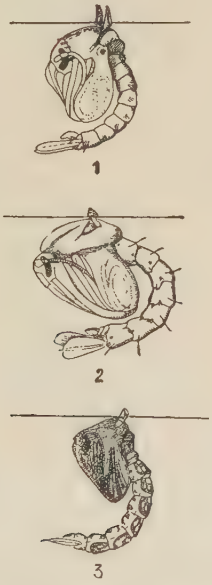
Fig. 30.—Eggs and larva of Culex and Anopheles.

several times, *i. e.,* shed their skin, and then they change their form into what are known as *pupae*. These, too, live in the

water, moving about by awkward, violent movements. The breathing apparatus, located just back of the head, gives the pupa the appearance of having two horns. This pupa stage lasts from one to two days, at the end of which time the pupa case splits at the top and the living mosquito, as we know it, emerges.



Larva of Anopheles quadrimaculatus. (Castellani and Chalmers.)



Pupae: *1*, Culex; *2*, Anopheles; *3*, Aedes aegypti. (After Howard.)

Fig. 31.—Larva and pupae.

Only the female mosquito sucks blood; the male subsists upon the juice of plants and fruits or often eats nothing, dying soon after having fulfilled his mission. The female lives a month or more. Inasmuch as both larvae and pupae must come to the surface to breathe, it has been found that they can readily be killed by floating a fine film of crude petroleum over the surface of the water in which they live. This asphyxiates and poisons them.

Small fish are the greatest enemy of mosquitoes in the aquatic stage, but they cannot be relied upon to keep a pond

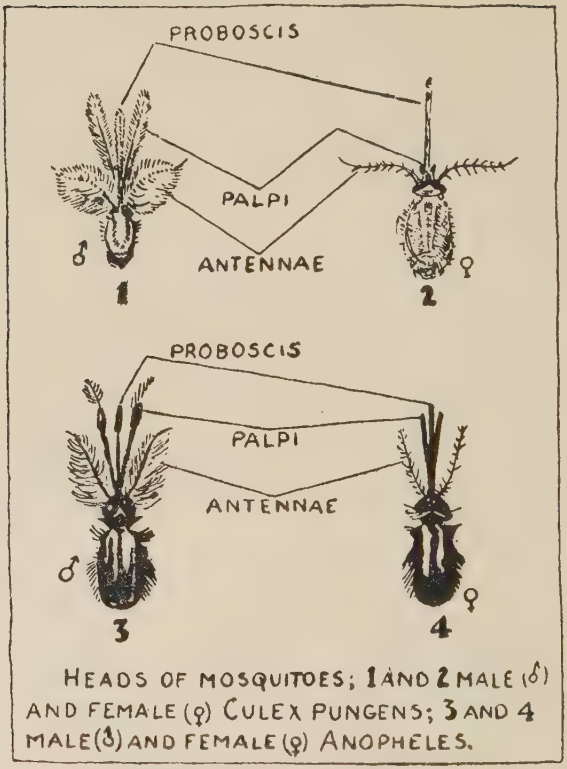


Fig. 32.—How to distinguish mosquitoes.

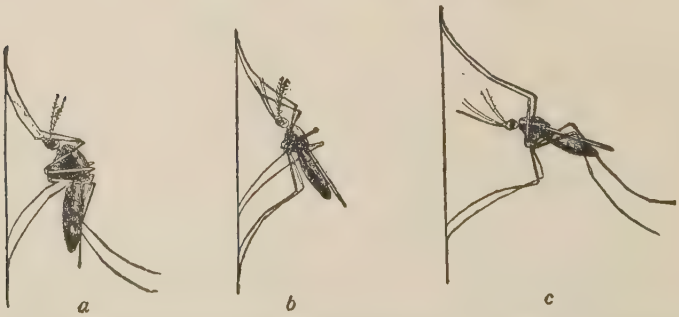


Fig. 33.—Various mosquitoes in attitudes of repose: *a*, Culex pipiens; *b*, Myzorhynchus pseudopictus; *c*, Anopheles maculipennis. (After Manson.)

clear if its margins are densely overgrown with reeds or other vegetation. The Culex mosquitoes breed in natural pools of all sizes where fish are absent, in sewers, cesspools, drains, rain-filled tin cans and boxes, rainpools in hollow trees and post-holes, vases, fountains, in short, anywhere where water stands two or three weeks without drying up. Many varieties of Culex live in salt marshes.

In contrast to the Culex, the *Anopheles* mosquito, which is the carrier of malaria, prefers fairly clean water in puddles, ponds and sluggish streams in the woods, fields and swamps. The eggs which it lays on the surface of the water do not adhere to one another, but float about separately like tiny boats. When the wigglers of the Anopheles come to the surface to breathe they assume a horizontal position, almost parallel to the surface. The winged insects of Anopheles and Culex can be distinguished from one another by the position they assume on a wall. Besides, Anopheles and Culex differ in their habits, the Anopheles flying about chiefly at night.

Unlike the Anopheles, the *Aedes aegypti,* which transmits yellow fever, is a domestic insect, like Culex, breeding by preference in any standing water about the household, for example, in cisterns, rain-barrels or in water that may have collected in buckets, bottles or old cans. It does not breed in the fields, woods and swamps, which are the favorite resorts of the malaria mosquito. It is active chiefly during the day. The eggs are laid on water or in the mud just above the waterline. They do not form rafts, but float about separately. Soon after having been deposited they turn a deep black.

Flies.—The adult female house fly lays its eggs in manure or other organic refuse, depositing 100 or more eggs at a time. In six to eight hours the eggs hatch into *larvae* (maggots) which grow rapidly, moult several times, and are fully developed in four to five days. In the course of their development the maggots migrate and burrow into the soil if they can reach it. After the maggot has obtained maturity its skin hardens and it becomes a brown, motionless object which looks like a large fat grain of wheat. This is the *pupa* within which the fly develops to full growth. Many maggots and pupae may usually be found in the ground on the edge of a manure pile, even when the soil is compact and hard. When

the fly is fully grown it emerges from the pupa, thus completing the cycle from egg to fly. The entire process usually takes from ten to fourteen days.

Examined with a strong magnifying glass, flies are seen to be covered with hairs and bristles which readily entangle dirt, dust, and bacteria. The mouth of the fly consists of a flexible tube, like an elephant's trunk, ending in a flat disk. Only liquid food can be sucked up; when a fly feeds on a dry substance it first dissolves this by regurgitating a few drops of fluid through the mouth tube.

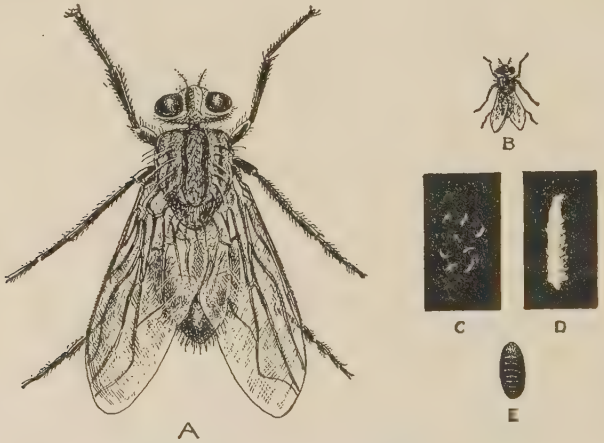


Fig. 34.—House fly, Musca domestica: *A*, adult female, enlarged; *B*, natural size; *C*, eggs; *D*, larva; *E*, pupa. (After Rivas.)

In order to prevent fly breeding, special attention should be given to cleanliness about stables, pig pens and the like, and to proper disposal of manure, garbage and rubbish. If possible, manure should be hauled away once a week or oftener, or it should be stored in tight vaults properly screened against flies. It has been recommended to sift borax over the manure (1 pound to 8 bushels of manure), and then sprinkle the pile with a little water. Strong disinfectants cannot be used, for they destroy the fertilizing value of the manure. Garbage should be kept covered, and not allowed to accumulate.

Tsetse Flies (*Glossina palpalis and G. morsitans*).—This fly, the dreaded carrier of African sleeping sickness, is found in tropical Africa, usually in the neighborhood of water courses. It is scarcely larger than the common house fly, which it resembles in its general shape; in color, however, it is more like that of a honey bee. The tsetse fly subsists on blood and must obtain the blood of a vertebrate animal every two or three days. The larvae remain in the body of the mother fly until fully developed and are then dropped on moist soil, in which they burrow to undergo transformation to the adult stage. Clearing the brush exposes the earth to

Fig. 35.—Tsetse fly (Glossina palpalis). At the left a perfect insect just escaped from the pupa. At the right a tsetse fly before and after feeding. (After Brumpt.)

the sun, and the surface becomes hard and dry, so that the flies die during the pupa stage.

Fleas.—Fleas are wingless creatures which, like the fly, pass through several stages in their development. The adult female deposits her eggs among the hair or fur of the host animal. The eggs, however, are not fastened to the hairs, and therefore fall freely to the ground. (Contrast this with the eggs of lice, page 59.) They are oval, whitish and smooth, and about ½ millimeter long. In two to five days the eggs hatch into *larvae,* which are small wormlike creatures, whitish or yellowish in color, consisting of a head and thirteen segments. The larvae feed on almost any kind of refuse and dust. This larval stage lasts for a week or ten days during which the

larva sheds its skin three times. At the end of this time it spins a flat, silken cocoon and becomes a *pupa*. After five to eight days this cocoon opens and the adult flea emerges. The length of this cycle, from egg to flea, usually occupies eighteen days to three weeks.

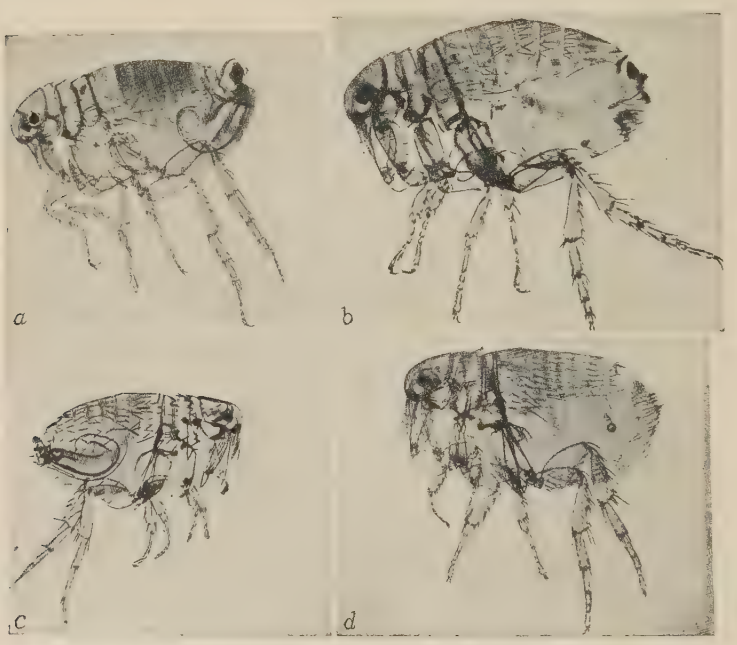


Fig. 36.—Various fleas, magnified about 30 diameters: *a*, Pulex irritans, ♂ ; *b*, Pulex irritans, ♀ ; *c*, Xenopsylla cheopis, ♂ ; *d*, Xenopsylla cheopis, ♀ . (Bacot, in Journal of Hygiene, Plague Supplement III, 1914.)

Both the male and the female flea bite to obtain blood, and while different species prefer certain hosts, the commonest varieties attack several hosts, including man. Over 300 species of fleas are known, the common house flea being *Pulex irritans;* the dog flea, *Pulex serraticeps* or *Ctenocephalus canis;* the Indian rat flea, *Xenopsylla cheopis;* the common rat flea of Europe and North America, *Ceratophyllus fasciatus.*

In ridding a house of fleas one can resort to fumigation

with sulfur dioxide. Formaldehyde gas has little value for this purpose. In addition to the fumigation one should scrub the floors with soapsuds to which kerosene has been added. Instead of this, one can sprinkle flake naphthalene about on the floor, leaving the room closed over night.

When handling rats, squirrels and other animals suspected to be plague infected, chloroform or ether may be applied to the hosts and the fleas then removed by combing.

Bedbugs.—The very flat body of bedbugs enables these animals to hide in the narrowest cracks of beds and walls. They may live for incredibly long periods of time without food. The animal is nocturnal in its habits, and its food is blood.

The eggs laid by the adult insect are white, oval objects laid in batches of from 50 to 60. They hatch in a week or ten days into *larvae* which are yellowish-white insects, resembling the adult in structure and habits. These young forms moult five times, the insect gradually becoming larger and darker. Under favorable conditions about seven weeks elapse from the egg to the adult insect.

The most practical way of eradicating bedbugs is by a very liberal application of gasoline or kerosene. Turpentine is also of value. Fumigation with hydrogen cyanide, sulfur dioxide, or carbon bisulfide may be employed. In ships, sleeping-cars and the like, fumigation with hydrogen cyanide is the best method, but it should be entrusted only to experts.

Ticks.—Ticks are not true insects (in the scientific sense), but are closely related to the itch mites. In some of their habits they resemble bedbugs, for they take no vegetable food, but live on blood.

The life cycle of the tick consists of four stages, spoken of as the egg, larva, nymph, and adult tick. The eggs are invariably deposited on the ground in large masses. The *larvae* which emerge from the eggs are minute six-legged creatures. The larvae attach themselves to a suitable host, upon which they feed, then drop to the ground, and moult, becoming *nymphs*. The nymphs have eight legs. They, too, attach themselves to a host, engorge themselves with blood; then, usually, they drop to the ground, moult their skins, and become adults.

Ticks upon domestic animals may be controlled by dipping, spraying, or by hand methods. The last-named is important in the case of dogs, which are frequently infested with wood ticks. These serve as a vector for the dangerous human infection, "Rocky Mountain spotted fever," a disease found over an extensive area of the northern United States. Ticks are also involved in the spread of other infectious diseases to man. In controlling ticks by the dip method (principally for cattle), the dip most commonly used consists of a solution containing 0.2 per cent of arsenic. Crude petro-

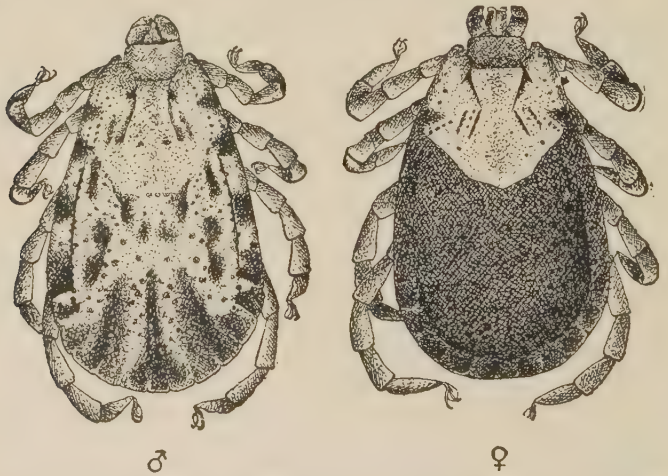


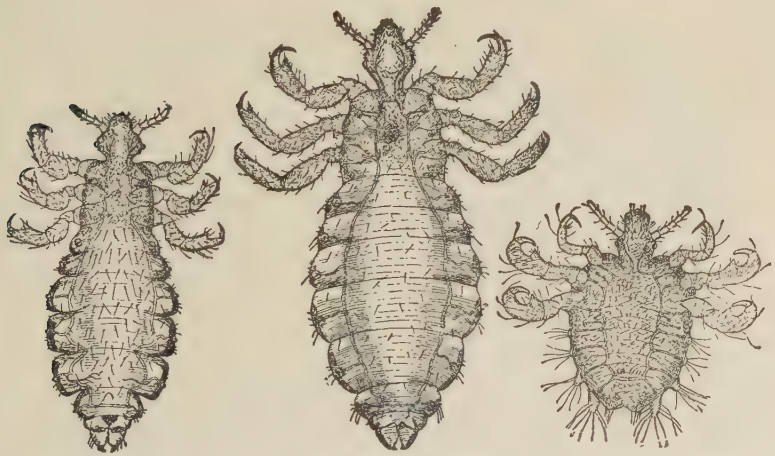
Fig. 37.—Dermacentor venustus, male ♂ and female ♀, the tick of Rocky Mountain spotted fever. (Rivas after Chandler.)

leum has also been used, but is not so good for the cattle. For most tick-borne diseases, cattle must be dipped or treated weekly.

Lice.—Lice or pediculi are wingless insects, parasitic during their entire life on warm-blooded animals. They do not travel much and keep fairly close to one host. Three kinds of lice are parasitic in man: (1) the head louse, *Pediculus capitis*, in the hair of the head; (2) the body louse, *Pediculus corporis* or *vestimenti* in the underclothing; and (3) *Pediculus pubis* (crab louse) in the covered hairy parts of the body, especially in the pubic hair.

In the case of head lice and crab lice, the time during which the lice have infested the body may be estimated by the length of the hair between the egg and the skin, for the egg, when deposited, is attached to the hair near its root, and as the hair grows, it carries the egg away from the body.

The eggs (*nits*) are slightly elongated and fastened to the hair or clothing of the host. They hatch in ten to fifteen days, the young coming out of the top of the egg. These do not differ much in structure from the adults, but are paler in



Pediculus capitis. Pediculus corporis. Pediculus pubis.
Female; dorsal surface (× 25). (Courtesy of Dr. L. A. Duhring.)

Fig. 38.—Head louse, body louse, crab louse.

color. They moult their skin a few times, usually four, before they are mature.

Delousing is not difficult under normal peacetime conditions, but in times of war it constitutes a serious problem. One of the most reliable means of destroying lice in clothing is by means of steam under pressure. Immersion of the garments in gasoline is also highly effective and may often be more convenient. Where there is danger of fire, tetrachlorethane may be used, as this is not inflammable. While the

clothing is being disinfected the infected individual must thoroughly cleanse his body with soft soap and water.

For head lice it is advisable to apply crude petroleum to the hair and scalp at night and then bind a towel about the head. The next morning the head is washed with soap and water, after which the hair must be very thoroughly combed with a fine comb to remove the lice and nits. The latter adhere firmly to the hair and must usually be removed individually by hand.

To keep lice away, the application to the body of a grease containing naphthalene, coumarin, or certain other odorous substances has been recommended. The effect of this wears off as the grease is absorbed by the underclothing; nevertheless the treatment is of service.

Roaches.—There are many different species of roaches, the commonest being *Blatta germanica,* known as the croton bug in this country, and *Blatta orientalis,* or black beetle, which is the common European and English species. The croton bug is the smallest of the domestic roaches, but it multiplies more rapidly than any of the other species.

Domestic roaches feed on almost any dead matter, and soil everything with which they come in contact. The eggs are brought together within the abdomen of the mother into an egg capsule, which is a hard horny pod. It is retained in this position sometimes for weeks, or until the young larvae are ready to emerge. The young are very much like adults, except in point of size, and in lacking wings. They moult five or six times before they become adults.

The control and eradication of roaches demand cleanliness, the elimination of breeding and hiding places, and the use of poisons. Fumigation with sulfur dioxide or hydrogen cyanide is effective, but usually several fumigations are necessary. The best poison is sodium fluoride, though borax is also of service.

The reader will find much additional useful information in the publications of the Bureau of Entomology of the U. S. Department of Agriculture.

CHAPTER V

DISINFECTION

Disinfection is the destruction of the agents causing infection. This destruction can be accomplished by various means, such as sunlight, the application of heat, exposure to germicidal gases or to ultraviolet rays, or by means of chemicals.

Sunlight is a valuable disinfecting agent, especially when it is combined with exposure to air. The disinfecting action of sunlight *per se* is due principally to the ultraviolet rays. When one considers the enormous number of pathogenic bacteria constantly being discharged into the air and on the ground and contrasts this with the small number of such germs that can be recovered from the dust of streets and other public places, one realizes to what extent natural disinfection must be going on. This is very largely due to the combined action of sunlight and air (drying). Even so resistant an organism as the tubercle bacillus is usually killed when bits of sputum containing the organisms are exposed to the combined action of sunlight and drying. The action of sunlight is, however, uncertain because the amount of sunshine is variable. This natural disinfectant is, therefore, only relied upon as a supplement to the more intensive methods.

Heat is one of the most valuable disinfectants. It has a wide range of applicability, and is very reliable. Depending on the nature of the material to be disinfected, heat may be used in the form of fire, dry heat, boiling water, live steam, or steam under pressure.

Naturally the easiest and quickest way of disposing of infected materials is to burn them. Infected mattresses, rugs, books, papers and magazines, toys, pus-soaked dressings, paper sputum cups, paper handkerchiefs, and other similar articles can be disposed of in this way.

When burning is out of the question we can often use dry heat as a disinfectant. Special dry heat sterilizers are con-

structed for this purpose, but in the home the oven of a kitchen stove will often answer as well. Dry heat is extensively used in sterilizing glassware in the laboratory.

One of the simplest methods of disinfection is by boiling in water. This is well suited for soiled linen, dishes, trays, bedpans and other articles that have come in contact with infectious material.

Live steam is also very useful as a disinfectant. In dairies and creameries a jet of live steam is widely employed to insure the cleanliness of milk cans. In bacteriologic laboratories it is used for the sterilization of media.

Steam under pressure is one of the most effective means of disinfection we know, but it requires a special type of apparatus. When under pressure steam has much greater power to penetrate to the interior of bulky articles such as mattresses, bundles of dressings, and clothing. It also has the advantage of killing the more resistant spore forms of bacteria.

Chemicals form another important group of disinfecting agents. The more common ones are bichloride of mercury, carbolic acid (phenol), quicklime, chloride of lime, iodine, formaldehyde, peroxide of hydrogen, and sulfur dioxide gas. Depending on the intensity of their action, disinfectants are classed as "germicides" (germ killers) and "antiseptics" (preventers of germ growth). Every germicide in diluted form is an antiseptic. Many patented preparations widely advertised as remarkable disinfectants have only slight disinfecting value. An important fact to remember in connection with chemical disinfectants is the necessity of bringing all parts of the infected material in close contact with the disinfectant. For example, in the case of typhoid stools, it is important to stir the stool thoroughly with a stick after adding the disinfectant, so that the fecal masses may be broken up, thus permitting the disinfectant to act on all of the fecal material.

Many disinfectants combine with albuminous material. When considerable quantities of such material are present, larger amounts of the disinfectant must be used than would be necessary if only the naked pathogenic bacteria had to be dealt with.

Gaseous disinfectants (especially formaldehyde and sulfur dioxide) are still used to fumigate rooms which have been

occupied by persons ill with contagious disease. Experience has shown that much of this "terminal fumigation," as it is called, is unnecessary, for sufficient disinfection can usually be accomplished by cleaning and scrubbing the apartment and then giving it a thorough airing. However, fumigation with sulfur is very useful in killing mosquitoes and other insect carriers of disease. Hydrogen cyanide is used to fumigate ships in order to rid them of rats and other vermin. This gas is extremely dangerous and should be used only by experts.

Ultraviolet rays have been used to disinfect water supplies and especially to disinfect the water of swimming pools. The method is not superior, however, to disinfection by chlorination.

Internal Disinfection.—A word may be said about the internal use of disinfectants as a means of combating infection.

At one time it was thought possible to administer disinfectants in typhoid fever and other intestinal infections in such manner and in such doses that the infecting micro-organisms would be killed. A great deal was said about "intestinal antiseptics," but experience has shown that most of these are wholly ineffective in accomplishing their purposes, and their use has accordingly been abandoned by scientific physicians. Benzoic acid, urotropin, mandelic acid and sulfanilamide, however, appear to have value as urinary antiseptics.

Theoretically it is of course conceivable that certain infectious diseases will be amenable to treatment with internal disinfectants. This line of research was, in fact, long pursued by Ehrlich and his pupils. They attempted to synthesize chemical substances which would have a marked germicidal effect on the infecting micro-organism while at the same time having little toxicity for man. In syphilis, Ehrlich's researches were highly successful, for the drug arsphenamine (salvarsan) has just such a selective action. Morgenroth synthesized a substance, ethyl hydrocupreine, which he found highly germicidal for pneumococci and of value in experimental pneumococcus infections. Clinical experiences, however, have shown that the use of the drug in man is not at all free from danger.

Since 1935 great advances have been made in this field because of some experimental observations first made by

Domagk* and subsequently continued and extended, especially by English investigators. These led to the production of a chemical compound called "prontosil" or "sulfanilamide," which was found to have a marked destructive effect on various pathogenic streptococci. Clinical trials of the drug in streptococcal infections were attended with remarkably favorable results. Subsequently the drug was used also in the treatment of gonococcal, meningococcal and other infections, in some of which truly astounding cures were effected. More recently other related compounds, "sulfapyridine," "sulfathiazole" and "sulfadiazine" have been successfully used, especially in pneumococcus infections. As a group these drugs are spoken of as the "sulfonamides." The mode of action of these drugs is not entirely clear. Recent studies indicate that in some way these drugs interfere with the nutrition of the micro-organisms, which then die of starvation. The further developments in this field will be watched with interest.

* Deutsche med. Wochenschrift, Vol. 61, 1935.

CHAPTER VI

NONCOMMUNICABLE DISEASES AS HEALTH PROBLEMS

In the preceding four chapters attention has been given to certain general considerations regarding the communicable diseases, their mode of spread and the methods of their control. The more important of these diseases will be taken up in subsequent chapters.

The communicable diseases, however, are by no means the only conditions which affect public health. Neither are they the most prevalent. There is a host of pathological conditions, some of them existing at birth, others developing during life, which should have our attention. Some handicap the individual throughout life. As examples may be mentioned such congenital malformations as harelip, cleft palate, birth palsies, clubfoot and disfiguring birthmarks. Some doom the victim to custodial care in an institution almost from infancy. Chief among this class are idiocy and imbecility. By far the larger proportion of the pathological conditions under consideration develop insidiously in middle and later adult life. Some of them merely handicap without endangering life. Examples of these are deafness, failing eyesight and various forms of arthritis and rheumatism. Others are serious diseases often ending fatally. Among these may be mentioned various diseases of the blood such as leukemia, and pernicious anemia, various forms of mental alienation, diseases of the heart, arteries and kidneys, various forms of malignant disease such as cancer, diseases of the stomach, liver, gallbladder and intestines, and certain obscure diseases of the central nervous system, such as migraine, tics, shaking palsy and the like. Still others make the life of the victims miserable, though they never cause death. Examples of these are hay fever and other manifestations of allergy.

This large group of noncommunicable disorders presents some of the most difficult problems in medicine. In very many

cases the causative factors are still very obscure. Throughout the world clinicians and laboratory workers are busily engaged in seeking a solution of the many problems involved. From time to time an investigator is able to make an important discovery which marks a great advance. Such was the case, for example, when Banting and Best succeeded in preparing insulin, and when Minot discovered the value of liver in the treatment of pernicious anemia.

Considerable progress has been made in dealing with a number of conditions which formerly were both prevalent and serious. Scurvy, rickets, beriberi and pellagra are outstanding examples of these. Their control was made possible by the discovery of the rôle played by vitamins in nutrition. Progress is also being made in another direction as the result of a better understanding of the nature and rôle of certain internal secretions spoken of as the endocrines.

But we seem as far away from the goal as ever in unravelling the mystery of cancer, or arteriosclerosis, or peptic ulcer, or rheumatic fever, or chronic rheumatism and arthritis, to mention only a few common conditions.

Further progress in public health is thus largely dependent on discoveries and advances in medical science.

CHAPTER VII

PRINCIPLES OF NUTRITION

The body needs food for several different purposes: for growth, to supply muscular energy and heat, and to replace tissue waste. In addition, the body needs water and mineral salts so that the chemical reactions, which must take place in order that the food may be utilized, can proceed properly. There are two principal classes of foods: fuel foods and building foods. The fuel foods furnish heat and muscular energy; the building foods furnish material to make new body tissue. They thus provide for the body's growth and for the replacement of worn-out body cells. It must not be supposed, however, that any given food is always solely a fuel food or a building food. There are, to be sure, a few foods that have only a single function; for example, the sole function of the starches and fats is to serve as fuel, but most of our common foods contain both building and fuel constituents. As examples we may cite milk, meat and cereals.

Fuel Requirements.—An automobilist knows just about how much gasoline he will require for every hundred miles; an engineer can calculate how much coal he will require to run a power plant, or to heat a building. So, too, we know how much food a person will need when he is doing hard muscular work, or moderate work, or when he is resting. Engineers long ago discovered that different coals differ considerably in heating value. They finally agreed to grade coal according to the amount of heat a given weight would produce. They express this in thermal units. Inasmuch as the fuel foods used by the body are in every way comparable to the coal or other fuel used by the engineer, scientists have graded fuel foods, too, according to the amount of heat which they will produce. It must be remembered that heat can be changed into kinetic energy and the value of fuel foods can be expressed in terms of heat units.

The amount of heat which a given fuel food will yield can be determined accurately by laboratory tests, and is expressed in units called *Calories*. A Calorie is that *amount of heat* which will raise the temperature of 1000 cc. of water just 1° C. This can also be expressed as the amount of heat necessary to raise the temperature of 10 cc. of water from the freezing point (0° C.) to the boiling point (100° C.). In other words, a Calorie is a measure of *heat*, just as an inch is a measure of length, a pint a measure of volume. So much has been written about Calories that some persons have gained the impression that Calories are a constituent of food, comparable, for example, to sugar or fat. When a given amount of butter is said to "contain 150 Calories" the expression merely indicates how much heat it is able to furnish.

It has been found that an ordinary adult doing a moderate amount of muscular work requires fuel food to supply about 3000 Calories a day. In cold weather more heat units are required than in warm weather, since the body loses heat in larger quantities. Those doing light office work require less fuel food than those who do hard physical labor. Those at rest require still less. Women require somewhat less than men. In proportion to their size, children require large amounts of fuel food, this being due to the fact that they are so active.

In order that the reader may have some idea of the heat value of different foods, the following list is given:

	Calories per pound.
Butter	3800
Sugar	1900
White bread	1250
Milk	325
Potatoes (raw)	385
Rice	1600

Fats and Carbohydrates.—When we examine the fuel foods we find that they fall into two large groups, namely, fats and carbohydrates. The term "fats" as used in chemistry includes many substances which we ordinarily speak of as oils. But the reader must be cautioned against regarding all oils as fats, for there is a large group of oily substances which,

chemically, are entirely unrelated to the true fats. Familiar oils of this kind are the various paraffin oils, petrolatum, vaselin, mineral oil, "Russian oil," Nujol, etc. This fact deserves special emphasis, for, unlike the true fats, none of these oils have any food value whatever. The true fats used as fuel foods embrace butter, lard, suet, olive oil, cottonseed oil, peanut oil, corn oil and other vegetable oils, and animal oils such as cod liver oil.

The carbohydrates embrace what we ordinarily call "sugars" and "starches." Among sugars, the most common are cane sugar, milk sugar, grape sugar, honey, molasses and syrup, and maple sugar. The commoner starchy foods are wheat flour, potatoes, rice and other cereals. The starches are closely related to the sugars and are changed into sugar in the process of digestion. Both carbohydrates and fats are substances of quite simple chemical composition, and contain only the elements carbon, hydrogen and oxygen.

Proteins.—Our comparison of the human body with a steam engine holds good only so far as the fuel foods are concerned, for the body is many times more wonderful than the most perfect machine ever devised, since it constantly replaces worn-out parts. This it does out of certain constituents of the food, the proteins and mineral salts.

The term "protein" does not denote a single substance, but a large class of organic substances of very complex composition. In this respect protein differs markedly from the fats and carbohydrates. In addition to the elements carbon, hydrogen and oxygen, the proteins always contain nitrogen and, with very few exceptions, sulfur and phosphorus; some always contain small amounts of iron as well. For our purpose it is sufficient to remember that proteins contain relatively large amounts of nitrogen, and that this is the important constituent necessary to their function as building foods.

Among the common foods which are rich in protein are meat, eggs, milk, beans, the whole grains of cereals, and nuts.

Careful investigations carried on over a series of years by Chittenden and his pupils show that about 90 Gm. (3 ounces) of protein per day is ample to keep the body at equilibrium, and that often 60 Gm. is sufficient. In practice, however, most experts on nutrition allow somewhat higher amounts.

Thus, the following average figures are given for the daily ration of soldiers:

	Proteins.	Fats.	Carbohydrates.	Calories.
In peace.....	130 Gm.	40 Gm.	551 Gm.	2900
In war.....	146 "	59 "	557 "	3250

Although the proteins are primarily building foods, they do more than build up and repair the body tissues, for only the nitrogenous part of the huge protein molecule is required for this purpose. The rest of the molecule supplies heat and energy to the tissues, so that protein acts both as a building food and as a fuel food.

Water.—It is impossible for the body to live without water. Water is required to dissolve the various constituents of the food, and to participate in the many chemical reactions which occur in the body during the process of digestion and metabolism. By the latter term is meant the chemical changes which go on constantly in all living cells, providing energy for the vital processes and activities and assimilating new material to repair the waste.

Mineral Salts.—The body also needs to be supplied with mineral salts. Thus calcium and phosphorus are required to build such tissues as bone, iron is required to supply the red blood cells with hemoglobin, salt (sodium chloride) is required as a source of the hydrochloric acid secreted by the stomach. Minute quantities of iodine are indispensable for the proper functioning of the thyroid gland. The common organic acids, such as citric acid and tartaric acid, are required by the body to aid in maintaining the alkalinity of the blood. In the process of digestion these acids are transformed into alkaline carbonates. It is usually unnecessary to make specific provision for all these minerals when constructing our dietaries, for nature provides them in many of our common foods and in our drinking water. We shall return to the subject when we discuss disorders of nutrition.

Vitamins.—During the past few decades we have come to recognize certain constituents heretofore entirely overlooked, and whose presence in the body is indispensable to proper nutrition. These substances, first described by Funk, are called

"vitamins," which exist in only very minute amounts in many different foods. The significance of the vitamins was first appreciated in connection with beriberi and scurvy. Subsequently other disorders were found to be due to a deficiency of certain vitamins.

Some years ago our knowledge of these very important substances was limited to four vitamins. They were designated by the letters of the alphabet as vitamins A, B, C and D. Further investigations have added to the number, for it was found that what had been called vitamin B was really a complex of several distinct vitamins. Today we speak of vitamin B_1 (also called thiamin), vitamin B_2 (also called riboflavin), vitamin P-P (*i. e.*, pellagra-preventive; nicotinic acid) and vitamin B_6, all of which are members of the vitamin B complex. Besides these there is a vitamin E, and a vitamin K.

Nature provides all the necessary vitamins (except vitamin D) in our common foods. Unfortunately in the case of one major source of the important vitamin B complex, namely wheat, rye and other cereal grains used mainly in the form of flour, we have foolishly put appearance before healthfulness and now deliberately discard a very valuable part of the cereal grains in the modern method of milling.

Special attention has been directed to this subject in England because of the importance of conserving the health and strength of the people in the face of a restricted food supply.

We quote from an article by Drummond in the British Medical Journal of June 8, 1940: "Modern white flour is made by crushing the grain between a series of rollers instead of grinding it between rotating stones. In roller crushing the little germ is flattened into a tiny disc and does not become pulverized as does the mass of starchy material forming the greater part of the grain. The germ is therefore held back when the crushed grain is sieved, and the flour is that much poorer.

"The differing character of the 'white' flour yielded by the stone mill and by the roller mill which rapidly ousted the former in the eighties of the last century, is well shown by the table on p. 72.

	Stone-ground white flour.	"Straight-run" roller mill bleached white flour.
Extraction, per cent	81.0	72.0
Protein, per cent	11.2	10.7
Fat, per cent	1.2	0.7
Carbohydrate, per cent	67.0	80.0
Calcium, mg. per 100 Gm.	50	22
Iron, mg. per 100 Gm.	4	1
Vitamin A, units per 100 Gm.	200	0
Vitamin B, units per 100 Gm.	150	22
Calories per 100 Gm.	370	370

"In respect to the major constituents—protein, fat, and carbohydrates—the differences are negligible. This is also reflected in the calorific value of the two types of flour. It was because of this that the new white flour seemed every bit as satisfying as had been the stone-ground flour of earlier times, and there is no doubt it attracted the public enormously."

The differences in the vitamin and mineral content as revealed by the table are striking, and show clearly the nutritional inferiority of the modern very white, highly "refined" flour.

From this it is clear that our diet should preferably include a substantial quantity of whole-grain cereals or foods prepared with stone-ground flour.

The laity has been bombarded with a great deal of misleading propaganda regarding the vitamins. Much of this has come from commercial concerns interested solely in promoting the sales of their products. Other such propaganda has come from those promoting various dietary fads. With the exception of vitamin D, all of the necessary vitamins are contained in the common foods available in the markets. It is neither necessary nor advisable for a healthy normal person to purchase them in the form of pills, capsules or liquids at a drug store. Some vitamins, for example vitamin C, are readily destroyed by cooking, especially if the food is alkaline. But this presents no difficulty, for many foods, such as fruits, lettuce and other salad vegetables are eaten raw. Moreover, vitamin C, especially abundant in citrus fruits and tomatoes, is plentiful even in cooked tomatoes, because these

are acid fruits. Vitamin D is not plentiful in any of the common foods. This vitamin is generated in our bodies through the action of sunlight on the skin. For this reason parents should see to it that their children, especially the babies, receive their full quota of sunshine. During the winter, when the sun is low, cod liver oil may be used as an additional source of vitamin D.

Balanced Diets.—We speak of a diet which provides all the various elements which the body needs to maintain health as a "balanced diet." Such a diet, as we have seen, concerns itself with many different factors. The kind and quantity of fuel foods, the proportion of carbohydrates to fats, the amount and kind of protein, the mineral content of the food, the acid or alkaline character of the mineral salts, the bulk of the food, its content of cellulose, the digestibility and palatability of the diet—these must all be considered. It is not merely a question of vitamins.

Mention has been made of the need of a sufficient amount of protein food in the diet. To provide this it is well to utilize meat, fish, eggs, milk and cheese as the principal sources of protein. It will be noted that these are all animal sources. Additional protein will of course be supplied by other dietary staples, such as wheat and other cereals, dried beans and peas, as well as other vegetables. Experience has shown that the proteins from animal sources are superior to other proteins, so that a strictly vegetarian diet is not advisable.

At this point the authors record their emphatic condemnation of the wholly unjustified prejudice held by many persons against what they regard as overeating of meat and other protein foods. Overeating of meat was undoubtedly common a century or more ago, but it is not true today. In fact, because of the desire of young women for a "slim boyish figure," and because of the overemphasis on the value of green leafy vegetables and salads, and finally because of the supposed strain put on the kidneys by the excretion of the protein metabolic products, the pendulum has swung to the other extreme. In place of the 90 Gm. of protein per day which Chittenden's studies showed to be desirable, many persons are now using diets which supply less than half this amount. It has been pointed out by many workers in the

field of nutrition that a low protein diet is not conducive to general health or to mental or physical efficiency. Fatigue, anemia, nutritional edema, lack of resistance to infection and other ill effects have been cited.

Ashe and Mosenthal* studied 1000 persons who came for a health check-up, though they did not regard themselves as ill. Sixty per cent of the subjects were found to be eating less than 42 Gm. of protein daily. The low protein eaters were mostly females. Among them low or low-normal blood pressure was observed frequently, as were also underweight and a mild secondary anemia (low hemoglobin). The high protein group was composed chiefly of males. The blood pressure was not elevated, the individuals were of average weight, there was no anemia, and the hemoglobin was normal.

Perhaps the most important rule in dietetics is the practice of *variety*. A monotonous, one-sided diet is likely to be disastrous. The science of nutrition has, indeed, made great progress during the past quarter century, but it is not probable that we already know all the various elements or factors which a healthful diet should provide. By varying the diet, making use of many different foods, eating some of them raw, avoiding fads of all kinds and employing common sense we shall probably not suffer from any dietary deficiencies.

* Jour. Am. Med. Assoc., April, 1937.

CHAPTER VIII

SOCIAL AND ECONOMIC FACTORS IN PUBLIC HEALTH

The relation between disease, on the one hand, and social and economic conditions on the other is a reciprocal one, each influencing the other. The influence of disease on economic conditions, however, was appreciated long before the influence of economic conditions on disease.

The economic loss caused by disease is enormous. Sickness surveys conducted by the United States Public Health Service, the Metropolitan Life Insurance Company, the New York Academy of Medicine, and other organizations indicate that the average wage earner loses from seven to ten days each year because of illness. It is stated that 2.5 per cent of American wage earners are constantly so sick as to be incapacitated for the ordinary pursuits of life. This means an economic loss running into hundreds of millions of dollars annually.

The direct losses from sickness fall under three heads: loss of wages, cost of medical care, and loss of earning capacity. The loss of wages in terms of dollars cannot easily be determined, since it differs so widely. It is perhaps most readily expressed, as has already been done above, by stating that the average wage earner is sick from seven to ten days during each year.

The cost of medical care varies considerably, but $20 to $40 per year is a low figure. In a study made some years ago by the United States Bureau of Labor Statistics such expenditures were tabulated for a group of families in Washington. It was found that the average expenditure for medical care increased as the income increased. This may be seen readily from the following table:

EXPENDITURE FOR MEDICAL CARE

Number of families.	Average annual income.	Average expenditures for medical care.
46	Less than $600	$12.83
117	$ 600–$ 900	25.52
167	900– 1200	42.31
198	1200– 1500	43.16
191	1500 and over	59.57

The loss of earning capacity is not easily determined, and it varies considerably according to the cause of the disability. It must be remembered that while in most diseases recovery is fairly complete, in others there is a marked diminution of subsequent earning power.

It attempting to discover how great a loss the death of a wage earner represents in dollars, Dublin has made some extremely interesting analyses. His calculations show that a man, who at age fifty would have arrived at an annual salary of $5000, would represent at age thirty a value of $48,000 in future *net* earnings. A man who would eventually reach an annual income of $2500 would attain his maximum value somewhat earlier. At age twenty-five the value of his future *net* earnings would be $31,900. The figures given are net earnings, so that they represent the monetary loss which the family would suffer through the early death of the wage earner.

Several years ago the senior author used Dublin's figures in supporting a plea for an increased budget appropriation for the control of pneumonia. He pointed out that in 1935 lobar pneumonia caused the death of 2039 males in New York City, 809 being males between the ages of 20 and 50. These 809 male deaths represented an economic loss of $20,000,000. It was argued that an expenditure of $500,000 for adequate pneumonia control work would probably effect a saving of $5,000,000. It is of interest to note that the funds were granted and that the total pneumonia deaths were reduced from 6500 in 1937 to 3400 in 1940.

In studying the economic importance of particular diseases we must consider the following factors:

(*a*) The degree of prevalence of the disease.

(*b*) The consequences of the disease.

(*c*) The duration of the disability.

(*d*) The age of those principally affected.

Diseases may be relatively mild, and yet, if extremely prevalent, may constitute an important health and economic problem. As examples we may mention common colds and dental caries.

Prevalence, however, is not the only factor which makes a disease important. Given two diseases about equally prevalent, that disease will be the more important from an economic standpoint which has the more disastrous consequences or in which serious sequelae are the more likely to develop. One may compare pneumonia and tuberculosis; scarlet fever and infantile paralysis; diphtheria and typhoid fever.

Similarly, two equally prevalent diseases may have quite different economic effects because the disability in the one case is a matter of days or weeks; in the other, of months or years. Pulmonary tuberculosis and pneumonia, for example, cause about the same number of deaths in many parts of the United States. The economic loss occasioned by tuberculosis, however, is by far the greater, owing to the fact that the average death from tuberculosis represents, say, a year's invalidism, while in pneumonia this period averages a week.

That the age of those affected by a disease is important in determining economic loss will be conceded at once. Assuming for a moment that in a given community the deaths from diphtheria, scarlet fever and measles combined were the same as those from lobar pneumonia, which group would occasion the greater economic loss? When one bears in mind that diphtheria, scarlet fever and measles affect principally children, and lobar pneumonia chiefly adults, the answer is plain. The deaths of adults cause a greater economic loss than those of children.

Let us now consider the influence which social and economic factors have on the occurrence of disease. That certain diseases are intimately associated with poverty was long vaguely realized. Only in recent years, however, has this association been carefully studied. In its study of sickness in New York City, the New York Academy of Medicine found that the lower the economic group, the higher the percentage of families affected by illness. In Illinois a similar study

showed illness in 63 per cent of the families with an annual income of $1600; 73 per cent in those with one of $1300, and 76 per cent in those with one of $800.

Additional data yielding the same picture will be found in the various reports published several years ago by the National Committee on the Costs of Medical Care, and in the reports of surveys on infant mortality in various parts of the United States made by the United States Children's Bureau. From one of the latter we reproduce the following typical table:

INFANT MORTALITY RATES BY FATHER'S EARNINGS

City.	Deaths of infants under one year of age per 1000 live births, by specified annual earnings of father.		
	All earnings.	$1250 and over.	Under $550.
All cities	111.2	64.3	151.4
Johnstown, Pa.	130.7	87.6	260.9
Manchester, N. H.	165.0	58.3	204.2
Saginaw, Mich.	84.6	22.2	142.0
Brockton, Mass.	96.7	73.5	167.1
New Bedford, Mass.	130.3	59.9	168.7
Waterbury, Conn.	122.7	68.4	151.1
Akron, Ohio	85.7	40.0	117.5
Baltimore, Md.	103.5	64.7	138.0

While the infant mortality rates throughout the United States are now substantially lower than they were when these studies were made, the relationships of the rates in the different income groups, as shown in the table, still hold true.

Statistics showing an unduly high death rate among Negroes are often advanced to show that Negroes, as such, have marked susceptibilities for a number of diseases. In New York City, for example, in 1938 the infant mortality rate for the city as a whole was 37.1 per 1000 births. Among the whites it was 36 while among the Negroes it was 67.3. Careful study of the figures shows that the high rate among Negroes

is caused by illegitimacy, syphilis, tuberculosis, overcrowding, gainful employment of mothers, lack of industrial opportunities for men, low average wages, and by the frequency with which infants were entrusted to mammies and irresponsible neighbors while the mother went out to work. In other words, the statistics cited above reflect social and economic conditions rather than any special racial susceptibility.

Let us see how social and economic factors operate in influencing the occurrence of diseases.

1. Social and economic conditions determine the character of the home environment.

2. They may determine unhygienic industrial conditions.

3. They determine the character of food and nutrition.

4. They may be one of the factors responsible for the occurrence of disease by making it difficult or impossible for the mother to devote the necessary care and attention to her home and family.

5. They determine the availability of qualified medical advice and treatment, and the possibility of following such advice.

6. They determine the character of personal hygiene.

7. They may determine the amount of healthful recreation which may be obtained.

8. They may determine the degree to which the community is educated.

It will be realized that the above eight ways in which social and economic factors operate are inextricably interwoven and interrelated. The whole matter is largely a matter of poverty. This poverty itself may be due to illness, or to the disruption of families by death of the chief bread winner, or by his desertion. It may be due to old age, to incapacity, to large families, to unemployment, or to low wages. Whatever its cause, in the absence of property to rely upon, it means inadequate food, poor housing, insufficient clothing, overwork and poor medical care. No matter how the subject is viewed, the fact remains that "poverty is the greatest problem in public health."

PART II. THE MORE IMPORTANT COMMUNICABLE DISEASES

CHAPTER IX

TUBERCULOSIS

Tuberculosis is one of the most prevalent infectious diseases. It affects not only man but also the lower animals. Moreover, it attacks all the tissues and organs of the body, so that we speak of tuberculosis of the lungs (consumption or phthisis), tuberculosis of the spine (Pott's disease), tuberculosis of the skin (lupus), tuberculosis of the joints (white swelling), tuberculous meningitis, glandular tuberculosis (scrofula), etc. Prior to Koch's discovery of the tubercle bacillus, it was not realized that these many different conditions were all related, and that they were all produced by the same germ. The splendid work of Koch not only demonstrated this fact conclusively but also served to call renewed attention to the enormous prevalence of infection with tubercle bacilli.

In the United States tuberculosis of all forms annually causes some 60,000 deaths, and the number of cases is estimated at about twenty times this figure. Inasmuch as tuberculosis usually runs a chronic course, the amount of invalidism it causes, and hence the economic loss due to the disease, runs into millions of dollars annually.

The most prevalent form of tuberculosis in man is pulmonary tuberculosis, which constitutes about 90 per cent of all the fatal cases. This form is also the most important from the standpoint of preventive medicine and public health, for it is mainly through it that the disease is spread. In a small proportion of cases, especially in children, tuberculous infection may be caused by drinking the raw milk of tuberculous cows, but in the spread of tuberculosis among adults the great source of danger to be considered is the coughing and spitting consumptive himself.

Causative Factors.—The essential cause of tuberculosis is the *tubercle bacillus,* discovered by Koch in 1882.* This is a small rod-shaped organism which, after having been stained with carbolfuchsin (the stain usually employed), holds fast to the stain even though subsequently treated with acids. In other words, it is one of the so-called "acid-fast" bacilli. The micro-organism is found in the tissues at the site of the lesion and in the pus produced by the breaking down of the tissues. If the lesion is in the lungs this pus, reaching the bronchi, becomes mixed with mucus and is coughed up and spit out. This sputum may be loaded with living tubercle bacilli. Moreover, experience has shown that a coughing consumptive expels tiny droplets of mucus into the air. These also may contain tubercle bacilli. But a person with pulmonary tuberculosis need not always have tubercle bacilli in the sputum. For a time the ulceration may proceed in such fashion that it does not open into the air passages. In this case, obviously, there will be no discharge of tuberculous pus into the air passages and therefore no tubercle bacilli in the sputum. A tuberculous person may have tubercle bacilli in the sputum for a time and then, as the lesion heals, may have a negative sputum. Should the lesions subsequently again become active so that the ulceration again extends into the air passages, the sputum will once more contain tubercle bacilli.

From a public health standpoint it is important to bear these facts in mind, for it is particularly the "open case," *i. e.,* the patient with tubercle bacilli in the sputum, who is a menace to others. The "closed case," *i. e.,* with negative sputum, does not spread the disease to others. However, since the latter may relapse and become an "open case," some supervision even of "closed cases" is advisable.

Not all persons into whose bodies tubercle bacilli penetrate develop tuberculosis. In fact, careful autopsy examinations have shown that there is hardly a person over thirty years of age who does not show signs of once having harbored tubercle bacilli in his body. In other words, we must realize

* According to modern scientific terminology this germ is now called *Mycobacterium tuberculosis.* In the text we shall continue to use the more familiar name tubercle bacillus.

that the tubercle bacillus is only one of the causes of the disease. Another important factor is the resistance of the individual. This resistance can be increased by attention to personal hygiene, good food, fresh air and sunshine. It may be broken down by any weakening influence, such as may result from attacks of other diseases, insufficient food or overwork. The question of wages is, therefore, intimately related to tuberculosis.

Occupation, too, has an important influence on the occurrence of tuberculosis. The lowest death rates from tuberculosis are among farmers. Those of hatters, printers and shoemakers are three or four times greater. Potters, lead miners, cutlers and grinders show rates seven or eight times greater than those among farmers.

From what has just been said, it will be clear that tuberculosis is a disease of the masses. It is, in fact, the best demonstration of the dependence of disease on social and economic factors. In this connection some figures collected by the Metropolitan Life Insurance Company* are interesting: The adjusted mortality rate during 1938 from all forms of tuberculosis for white male policy holders aged ten to seventy-four in the Industrial Department (small wage earners) was 60.8 per 100,000; for those in the Ordinary Department (higher economic group) it was 27.5; in the United States as a whole, the rate for white males aged ten to seventy-four was 48.0 per 100,000.

Heredity probably plays a rôle in tuberculosis, but only in the sense that a susceptibility to infection may be inherited. We have, however, no definite knowledge as to the nature of this susceptibility.

Relation to Age.—In man tuberculosis is encountered at all periods of life, from infancy to old age. In infancy the disease occurs most frequently in the form of a meningitis which is always fatal. In somewhat older children tuberculosis of the intestines and of the lymph glands is not uncommon. In almost all cases, careful examination shows that the primary invasion has its seat in the lungs, though often the lung lesion gives few signs or symptoms. In contrast to the find-

* Personal communication.

ings in adults, this primary focus in the lungs is very rarely located in the apex of the lung.

Tuberculosis claims its largest proportion of victims among young and middle-aged adults, often making itself manifest first during adolescence, and affecting chiefly the lungs. The disease usually begins insidiously, most frequently in the apex of the lung, and is often overlooked in its early stages. In females tuberculosis is the leading cause of death between the ages of fifteen to twenty years and it maintains this rank up to about the thirty-fifth year; in males it ranks first as the cause of death between the ages of twenty and thirty-five years.

As one surveys the tuberculosis death rates by age and sex groups over a period of years one might conclude that for males the age at which the risk of death is greatest had gradually advanced from the twenties to the fifties. This, however, is not the case as was clearly shown by Frost* in a paper published after his death. For all individuals, both male and female, the risk of death from tuberculosis is high in the first five years of life and then sharply declines, only to increase during adolescence and reach its peak during the twenties. Thereafter the tuberculosis mortality steadily declines.

Progress in Diagnosis.—Inasmuch as tuberculosis can often be arrested in its early stages, prompt recognition of the disease in its incipiency is most important. Up to about 1800, practically the only cases which physicians could diagnose as pulmonary tuberculosis were advanced cases of the disease which almost any layman today would readily recognize. Auenbrugger's discovery of the use of percussion, and Laënnec's introduction of the stethoscope for auscultation enabled physicians to detect the disease considerably earlier, and a still further advance was made when the clinical thermometer was introduced (Wunderlich, 1868). Microscopic examination of the sputum, made possible by Koch's discovery of the tubercle bacillus, constituted another step forward in the diagnosis of tuberculosis. Today, by means of *x*-ray photographs, the presence of tuberculosis can be discovered in the lungs well in advance of any signs detectable

* Age Selection of Mortality from Tuberculosis. Wade H. Frost, Milbank Memorial Quarterly, Vol. XVIII, January, 1940.

by the stethoscope, or before tubercle bacilli can be found in the sputum.

Tuberculin Tests.—At this point it will be well to say a few words about another diagnostic procedure, the *tuberculin test*. After von Behring had succeeded in immunizing animals against the toxin produced by diphtheria bacilli, Koch conceived the idea of immunizing humans with the poisons produced by tubercle bacilli. He grew tubercle bacilli in glycerin bouillon. After several weeks he filtered out the tubercle bacilli and concentrated the remaining liquid by evaporation. This concentrated liquid he called "tuberculin." Although

Fig. 39.—René Laënnec (1781–1826).

his immunizing experiments on humans ended disastrously, other workers gradually discovered that minute injections of this tuberculin gave valuable diagnostic information. It required some years of experimental study to learn how to use tuberculin for this purpose, and especially to determine the amount to be injected. As at present employed, a minute quantity of a very dilute solution of tuberculin is injected *into* the skin with a fine needle. This is spoken of as the "Mantoux test." If the body of the person so injected has not previously been invaded by tubercle bacilli, there will be no reaction at the site of injection; if, however, within a period of forty-eight to seventy-two hours a characteristic

red, inflammatory area develops, the reaction is said to be "positive," indicating that somewhere in the body there are tubercle bacilli. It is important to remember, however, that presence of tubercle bacilli in the body is not synonymous with *tuberculosis.*

By the extensive use of this test we now know that even babies born of tuberculous mothers are usually free from tubercle bacilli at birth. Kept amid tuberculous surroundings the infant is apt soon to be infected. In other words, at birth the Mantoux test will be negative, but after a time, if the infant is retested, the test will be positive. If an infant is born into healthful, nontuberculous surroundings, and kept away from known sources of infection, it may go for years and still give a negative reaction to the Mantoux test. This will be true also for an infant born of a tuberculous mother, provided the infant is at once removed into nontuberculous surroundings.

Immunization.—Attempts to immunize against tuberculosis by means of tuberculin having yielded discouraging results, various investigators sought to achieve this end by the use of vaccines made of *living* tubercle bacilli. A vaccine of this kind which has attracted considerable attention is that devised by Calmette and Guérin and usually spoken of as B.C.G. This is a culture of tubercle bacilli which through long cultivation on a special medium has become harmless to humans. According to Calmette the vaccine must be given in very early infancy. On the fifth, seventh and ninth days after birth, at intervals of forty-eight hours, the infant is made to swallow a dose of 1 cgm. of bacillary vaccine in a teaspoon and mixed with a few drops of milk. There is no febrile reaction and no discomfort of any kind. Calmette and his associates stated that after about twenty-five days the infant was immune to accidental infection. In France hundreds of thousands of infants have thus been treated, with, it is claimed, excellent results. In the United States, Park carried on studies with B.C.G. and reported encouraging results. Sufficient time has not yet elapsed to express a definite opinion as to the protective value of this form of treatment.

Treatment.—Over fifty years of patient research have thus far failed to discover any specific for the treatment of tubercu-

losis. All that medical science is able to do is to place the patient in the best possible condition so that his body may successfully cope with the invading germs. Rest, good food and fresh air make up the program of present-day treatment. The various surgical procedures now extensively employed are primarily a means of placing the affected lung at rest. In general the prospects for arresting the progress of the disease are the better the earlier the stage of the infection when the patient is placed under proper treatment, but cases are not at all uncommon in which the disease progresses rapidly even though treatment was begun very early.

Drolet has recently shown that over many years there appears to have been practically no reduction in the case fatality. It is, of course, well known that both the number of deaths of tuberculosis and the number of new cases have declined markedly practically everywhere. But the ratio of deaths to cases, *i. e.*, the case fatality, has remained almost unchanged. Thus, quoting Drolet:*

"During the twenty years from 1915 to 1935, in New York City, the number of new cases fell by 60 per cent and the deaths by 55 per cent; but the case fatality rate actually rose from 40 to 45 per cent, and, therefore, a given hundred cases of tuberculosis in 1935 suffered as high a mortality as the same number in the year 1915.

"In Chicago, during the last twenty years, the cases fell in number by 54 per cent; the deaths likewise; but the fatality of the disease remained the same, 33 out of a hundred both in 1915 and in 1935. Detroit, with its tremendous growth of population, shows increases in both the number of cases and deaths during the past twenty years, but a change in the fatality rate of only 5 per cent. In Philadelphia, the cases declined by 64 per cent and the deaths by 60 per cent; the case fatality increased by 6 per cent. In up-State New York, in the State of New Jersey, in Massachusetts and in England and Wales the cases fell in number anywhere between 42 and 55 per cent and the deaths practically likewise, between 40 and 57 per cent; but the seriousness of the disease there, too, remains practically unchanged."

* Godias, J. Drolet: "Present Trend of Case Fatality Rates in Tuberculosis," Amer. Review of Tuberculosis, Vol. 37, No. 2, Feb., 1938.

From what has been said it is clear that we must rely entirely on *preventive measures* for the reduction of tuberculosis mortality. This does not mean any abatement in our efforts to provide hospital and sanatorium facilities for the care of the tuberculous, for after all in a worthwhile proportion of the patients the disease can be arrested. Moreover, this segregation of patients with active disease from the rest of the community undoubtedly prevents many additional infections, and thus constitutes an important feature of the preventive program.

Control Measures.—Inasmuch as infected sputum is the chief vehicle for the transmission of tuberculosis to others, control measures resolve themselves into two categories, namely, those dealing directly with the patient, and those undertaken by the administrative authorities for the community as a whole.

So far as the patient is concerned, chief emphasis must be placed on the proper *disposal of the sputum.* Perhaps the best way is to receive the expectorated matter into cloths or paper handkerchiefs which may be burned, or the material may be received into one of the various forms of sputum cups and finally burned or disinfected. Persons with pulmonary tuberculosis must be warned against the danger to others of coughing without holding a handkerchief before the mouth and nose; under no circumstances should they spit on the floor. With a tuberculous person in a family, repeated medical examinations of the other members of the household are important in order to detect the first signs of infection in these "contacts." Moreover such examinations may reveal the original source of infection, as, for example, in the person of a grandparent suffering from what was regarded as "chronic bronchitis," or of a domestic or lodger who has a slight but persistent cough ascribed to "catarrh."

Turning now to the control activities which are the responsibility of the administrative authorities, two facts brought out in the preceding pages must be borne in mind: (*a*) patients with minimal lesions can often be enabled to overcome their infection if placed under proper treatment, and (*b*) one of the important vectors for the spread of tuberculous infection to others is the undiagnosed case of tuberculosis. These are

two compelling reasons why health administrators should devote a large share of attention to "case finding," *i. e.*, to the discovery of all cases of tuberculosis in their community.

It is well established that *x*-ray photographs usually reveal pathologic changes in the lung before they can be detected by even a careful clinical examination. Until recently the cost of an *x*-ray photograph of the chest made on the usual photographic film made it impracticable to utilize such examinations on a large scale.

Within the past few years a practicable device for making *x*-ray photographs of the chest on a roll of sensitized photographic paper has reduced the cost of this valuable diagnostic procedure to the point where it is economically practicable to examine large groups of persons by means of routine *x*-ray surveys. How fruitful such routine surveys are in "case finding" is well shown by the surveys* carried out in New York City under the direction of Dr. Herbert Edwards, Director of the Health Department's Bureau of Tuberculosis. These surveys are still being continued. During the three years 1936–38 a total of 166,758 persons were thus examined. Of these, 2910, or 1.17 per cent, were found with active tuberculosis, while an additional 2 per cent showed signs of arrested tuberculosis.

Among 41,373 young people (high school and college students and enrollees in the National Youth Administration) less than 1 per cent showed signs of active tuberculosis and 1 per cent, signs of arrested tuberculosis. Among 9770 newly appointed city employees in the Fire, Health and Education Departments the findings were practically the same. Of 32,623 members of trade unions examined, only 1 per cent showed signs of active tuberculosis, but 5 per cent were found with signs of arrested tuberculosis. In the *x*-ray examination of 65,459 persons receiving "home relief," 3 per cent were found with signs of active tuberculosis while only 1 per cent showed signs of arrested tuberculosis. Among 4915 prisoners in the penitentiary or in the house of detention, 4 per cent showed active tuberculosis and an additional 5 per cent, signs of arrested tuberculosis. Finally, among 4716 homeless men at

* "Tuberculosis Case-Finding," supplement to American Review of Tuberculosis, June, 1940.

the municipal lodging house, there were 5 per cent with active tuberculosis and an additional 11 per cent with signs of arrested tuberculosis.

New York City's experience has convinced Edwards that it is economically wasteful to make such routine *x*-ray surveys among adolescent children. For this reason "case finding" among this group should usually consist of two steps, namely, a proper Mantoux test, and subsequently an *x*-ray examination of the positive reactors. This is also the procedure followed by the New York City Department of Health in the examination of contacts to a known case of tuberculosis.

The more specific responsibilities of the health administrator include: providing for the prompt reporting of all cases of tuberculosis; making available free laboratory services for sputum examinations; organizing home visiting of patients in order to discover sources of infection; providing facilities for the examination of "contacts"; providing special clinics for the examination and supervision of ambulatory cases, sanatoria for the treatment of early cases, and special hospitals for the care of advanced cases of tuberculosis; and finally, perhaps most important of all, carrying on an intensive campaign of health education of the masses in order to acquaint them with the nature of tuberculosis, the precautions necessary to prevent the spread of the disease, and the importance of early diagnosis and treatment.

While all possible steps should be taken to hunt out and deal with every case of tuberculosis as a potential source of infection, measures bearing on the social and economic factors should not be neglected. As a matter of fact the latter are often the more important. Improved housing, more rooms, more fresh air and sunlight, better food, shorter hours of labor, higher wages—these are essential for any successful and lasting control of tuberculosis as a disease of the masses. They are the community's responsibility.

Milk and Tuberculosis.—So far as the prevention of infection with the bovine type of tubercle bacillus is concerned, it is important to bear in mind that the ordinary milk supply is frequently contaminated with tubercle bacilli derived from tuberculous cows. In various countries, from 10 to 20 per cent of specimens of raw milk contain living bovine tubercle

bacilli. This type is closely related to but not identical with the human type of tubercle bacillus. It causes infection in humans, though much more frequently in children than in adults. Professor M. P. Ravenel deserves special mention as having been the first to isolate bovine tubercle bacilli from a child, and for insisting on bovine tuberculosis as a factor in human infections.

Since tubercle bacilli are killed by an exposure to heat, the simplest method of preventing infection through cows' milk consists in pasteurizing the milk supply. Pasteurization should consist of heating the milk to 143° F., and holding it at that temperature for thirty minutes. Wherever pasteurization has been adopted, milk-borne infections with these bacilli have been greatly reduced.

CHAPTER X

TYPHOID FEVER. PARATYPHOID FEVER. UNDULANT FEVER

TYPHOID FEVER

Until about twenty years ago typhoid fever constituted one of our most important sanitary problems. Since that time so much effective health work has been directed against it that it has become one of the less significant infectious diseases engaging the attention of health authorities. A careful study of this disease, however, is profitable, for it will familiarize the reader with a number of important principles of preventive medicine and sanitation.

Typhoid fever was not clearly recognized as a distinct disease until 1829, when Louis, a distinguished French physician, clearly described it. It remained for Dr. William Gerhard of Philadelphia (1837) to show how the anatomic lesions of typhoid fever could be differentiated from those of typhus with which typhoid fever had often been confused. The similarity in the diseases is indicated by the name "typh*oid*," the ending "*oid*" signifying "like," hence "like typhus."

Nature of Disease.—Despite Gerhard's splendid work it was not until the birth of bacteriology that a clear conception was obtained of the nature of typhoid fever, the causative factor and its mode of transmission. In 1880 Eberth demonstrated that the disease was caused by a specific germ which he called the typhoid bacillus.* In one way or another this germ enters the body through the mouth and stomach, lodging finally in the walls of the small intestine where it produces ulceration. In most cases the incubation period of the disease is from seven to fourteen days, most commonly about ten days. This is the period from the time the disease germs are swallowed until the first symptoms appear. The onset of the disease is characterized by headache, pains in the back and

* The newer nomenclature calls this germ *Eberthella typhosa.*

fever. The tongue is usually coated. In most cases the patient feels really sick and takes to his bed. Occasional cases are encountered in which for a considerable time the patient is up and about—the so-called cases of "walking typhoid." In a typical case of typhoid fever the temperature rises steadily during the first week and continues high throughout the second week. During this period the patient is often delirious and the stools may contain blood from the ulceration in the intestines. Sometimes this bleeding may be extensive owing to the erosion of a larger blood vessel. The ulceration may be so severe as to break through the wall of the intestine, allowing the intestinal contents to enter the abdominal cavity. This is spoken of as a "perforation" and is often fatal. During the third week of the disease the morning temperatures gradually decline and in the fourth week this is true also for the afternoon temperatures. Ordinarily an attack of typhoid fever lasts four weeks, though complete convalescence requires several weeks longer. The average case fatality is about 10 per cent.

The typhoid bacillus is a motile, rod-shaped micro-organism which grows readily on all the ordinary culture media, including milk. In water it does not multiply, but it may remain alive there for a week or more, depending on conditions. Frozen in ice, typhoid bacilli gradually die, so that at the end of a week not more than 10 per cent are alive, at the end of a month not over 1 per cent, and at the end of five or six months none survive.

Mode of Spread.—Inasmuch as the typhoid bacilli form ulcers in the small intestine, which open into the lumen of the gut, the fecal discharges of the patient contain large numbers of typhoid bacilli. In the early stages of the disease the bacilli are also present in the patient's blood, hence the diagnosis may often be established by means of blood cultures made from blood drawn from a vein. Occasionally the bacilli are found in the patient's urine. The most common vehicle of infection, however, is the stool laden with typhoid bacilli. When it is remembered that the disease is produced by swallowing typhoid bacilli, the fact remains, disgusting as it is, that every case of typhoid fever means a short circuit between the fecal discharge of one person and the mouth of another.

Let us consider some of the ways in which this connection is established.

In the first place, infected fecal material may find its way into drinking water. Until recently, in this country, by far the greatest proportion of cases of typhoid fever was due to *water-borne infection.* This is not surprising, when we consider the large number of communities taking their water supplies from lakes, streams and rivers, *i. e.,* from sources very liable to pollution with fecal material coming from surface privies, drains, overflowing cesspools, and the like,

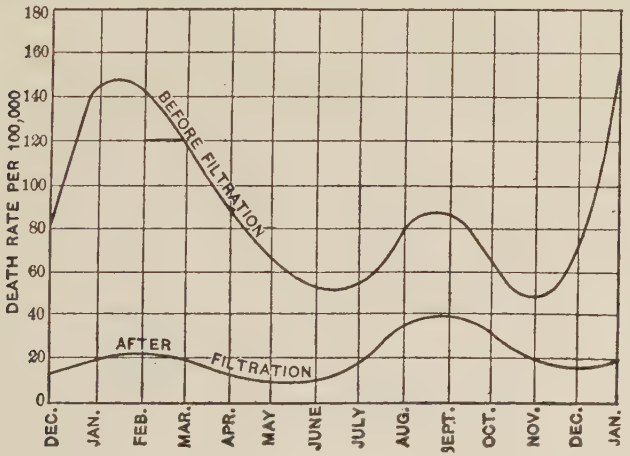


Fig. 40.—Seasonal distribution of typhoid fever in Albany, N. Y., before and after the filtration of the public water supply.

located within the watershed. To what an extent infected water supplies were responsible for the occurrence of typhoid fever in a community may readily be seen from Fig. 40, which shows the immediate and striking effect of purifying a badly polluted water supply. When public water supplies are polluted with sewage, the seasonal prevalence of typhoid fever usually shows a peak in the early part of the year, corresponding to the heavier pollution of the water as the result of the spring freshets. Later comes the usual seasonal rise in the late summer. This is well shown in Fig. 40.

It is not only the communities which draw their water

supply from a river which are thus menaced by typhoid infection through the introduction of large amounts of infected fecal material by such freshets. Again and again typhoid infection has menaced large rural areas because rivers have broken their banks and caused extensive floods which covered small villages and farms in low adjacent areas. As a consequence, wells and cisterns used as local water supplies are frequently polluted. When such floods occur, health authorities must give prompt warning of the danger of typhoid infection, advise the residents to boil all drinking water, give them expert assistance in disinfecting cisterns and wells when the flood has subsided, and offer antityphoid inoculations as an additional safeguard.

The next most common manner of transmission of typhoid fever is through *infected milk supplies*. In view of what has been said in discussing the spread of communicable diseases, it will be clear that there are many ways in which milk can become infected. Milk-borne infections frequently take on an explosive epidemic character.

In sections of the country where unsanitary outdoor privies abound, flies may be an important factor in transmitting typhoid infection. Interesting experiments have been conducted which show how the "fly which does not wipe its feet" may track enormous numbers of bacteria from an unprotected outdoor privy to food in the kitchen. If, perchance, such a fly drops into a pitcher of milk, ideal conditions are presented for infecting the milk with all the various germs carried on the legs of the fly. The picture (Fig. 41) shows the colonies of bacteria developing on a plate of sterile agar after a fly walked over the surface.

Typhoid fever has frequently been traced to the eating of *raw oysters* which had become infected by being grown or "fattened" in sewage-polluted waters.

Many cases of typhoid fever are *secondary, i. e.*, they develop in persons who have come into close contact with a case of the disease. This form of infection is most likely to occur when the patient is cared for at home and nursed by a member of the family.

Since both water-borne and milk-borne infections have been so greatly reduced, the mode of transmission which at

present is most prevalent is through *carriers*. This form of transmission has already been discussed (page 47). Carriers of typhoid bacilli are extremely common, and progressive health departments now maintain lists of all who come to their notice. Following an attack of typhoid fever, about 5 per cent of the convalescents continue to harbor typhoid bacilli in their stools for varying periods of time—in fact, some of them remain carriers for life.

Diagnosis.—In the diagnosis of typhoid fever an examination of the patient's blood for the Widal reaction often gives most valuable information, especially after about the seventh

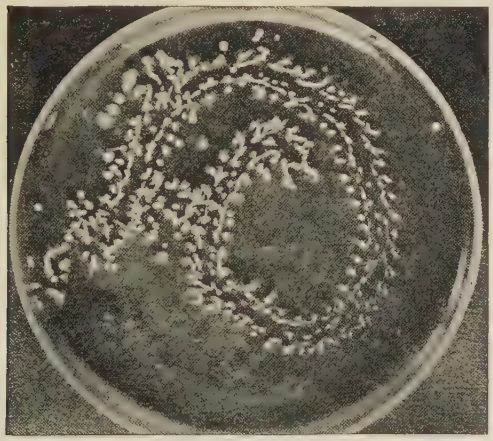


Fig. 41.—Colonies of bacteria transplanted by a fly's feet. (Magruder.)

day of the disease. The principles underlying this test are familiar to the reader (see page 39).

Another valuable aid in diagnosis is the appearance, about the sixth or seventh day, of peculiar, small, discrete, rose-colored spots on the patient's trunk. These "rose spots," as they are called, have been found to contain typhoid bacilli.

Early in the course of the disease bacteriologic examination of the patient's blood by culture method will frequently lead to the detection of typhoid bacilli. In modern hospitals this fact is utilized in establishing a definite diagnosis even before rose spots appear or before the Widal reaction is positive.

Control Measures.—From what has been said, the reader will understand the necessity of caring properly for a patient ill with typhoid fever. The *thorough disinfection and disposal of the patient's excreta* are especially important. Whenever possible the patient should be removed to a hospital, for it is usually difficult to carry out the necessary precautions in the home. It is well to bear in mind that typhoid bacilli are often present in the patient's urine. Disinfection should therefore include both urine and feces, the best disinfectant for this purpose being commercial "chloride of lime." All soiled bedclothes, napkins, towels, handkerchiefs, nightgowns, pajamas and the like, should be disinfected before being handed over for washing. Fly transmission should be guarded against by thorough screening of the sickroom.

In considering the measures which should be taken by the authorities to prevent typhoid infections, we may regard the protection and purification of the public *water supply* as of prime importance. Unless such a supply comes from sources which are absolutely safeguarded against pollution with fecal material, it should be purified by filtration, chlorination, or both. This applies to all supplies drawn from streams and rivers, and to many that are obtained from lakes. Water obtained from properly located artesian wells is usually free from pollution. Attention should also be paid to the sanitary disposal of sewage.

Experience shows that *water-borne* typhoid infection is often due to the drinking of water from springs and brooks by excursionists and others in the course of their hikes, or while camping. This form of infection can only be avoided by not drinking from these sources unless one knows positively that the water is not polluted. Various state authorities are now beginning to post signs at springs and brooks likely to be used by tourists, showing whether or not the water is safe to drink.

So far as *milk-borne* infection with typhoid fever is concerned, protection is best secured by pasteurization of all milk supplies. Wherever this measure has been enforced, milk-borne outbreaks of typhoid fever have practically disappeared.

In dealing with the prevention of *oyster-borne* typhoid in-

fections, health authorities must insist on placing a ban on oysters which have been grown or "fattened" in sewage-polluted waters. The so-called "fattening" process is particularly dangerous, and is no true fattening of the oyster at all, but merely a swelling due to the absorption of water. It has been found that oysters grown in sewage-polluted waters can purify themselves if left for a month or two in clear, unpolluted coastal waters during the closed season. In most parts of the United States the closed period usually extends from May or June to September. Experiments have also been conducted with weak solutions of chlorine as a means of disinfecting oysters from polluted sources, but this plan is not to be recommended.

The prevention of *secondary* infections depends on scrupulous attention to nursing technic. The greatest danger, of course, arises from cases of typhoid fever not recognized as such, and hence mostly from the mild and atypical cases.

The most baffling problem is still that of typhoid *carriers.* Since the female carriers are four or five times as numerous as the male carriers, one finds again and again that typhoid infections are brought about by typhoid carriers who prepare food for others. Our efforts must therefore be directed to discovering all typhoid carriers, to the end that they may be prevented from acting as food handlers (waiters, cooks, dairymen, etc.) and instructed as to the precautions they must take in order to avoid transmitting the infection. Persons in the family of a bacillus carrier should receive preventive inoculations of typhoid vaccine. The vaccine is usually given in three injections, a week apart, the immunity developing gradually within the next month or so.

Typhoid vaccination has proved of great value and it is to be recommended as a means of protection to all who are liable to be unduly exposed to infection, such as nurses, hospital attendants, soldiers in camps, and persons in the family of a bacillus carrier. It is also useful as a preventive measure for the general population in districts suddenly flooded through the overflow of rivers.

PARATYPHOID FEVER

Paratyphoid fever is very similar, clinically, to typhoid fever, and the causative micro-organism, the *paratyphoid bacillus,* is closely related to the typhoid bacillus.

Bacteriologists found that there are several types of paratyphoid bacilli and they spoke of them as paratyphoid A and paratyphoid B. These bacilli are now classed in a genus called *Salmonella,* five distinct species being recognized. Most of these are frequently found as the cause of outbreaks of food poisoning. The species Salmonella schottmülleri, formerly called paratyphoid B, more often gives rise to the typhoid-like disease here discussed.

Practically all that has been said in discussing typhoid fever is applicable to paratyphoid fever. However, in contrast to infections with typhoid bacilli, those caused by the paratyphoid bacilli (the so-called Salmonella) do not give rise to the chronic carrier condition.

UNDULANT FEVER

(Malta or Mediterranean Fever; Brucellosis)

The term, "undulant fever" is applied to an acute or subacute febrile infectious disease resembling typhoid fever, but characterized by a wavelike course of the temperature curve.

Undulant fever has long been known as "Malta fever" and also under a number of other names in various parts of the Mediterranean basin. In 1887, a small, short bacillus, the *Micrococcus melitensis,* was identified by Bruce as the causative micro-organism. Investigation showed that in Malta the infection was most commonly transmitted through the drinking of raw milk from infected goats, and this was since found true also for a focus of the disease among the goat-raising sections of Texas.

Subsequently it was found that a disease clinically indistinguishable from Malta fever was occasionally observed in persons who had become infected with a bacillus first described by Bang as the cause of contagious abortion in cows, an organism called *Bacillus abortus.* Through the work of Alice Evans we now know that the Micrococcus melitensis

and the Bacillus abortus are very closely related; they are different species of the same genus. In honor of Bruce the genus now bears the name Brucella, and bacteriologists speak of *Brucella melitensis* and *Brucella abortus*. Inasmuch as infection with Brucella abortus is very prevalent among cattle and hogs in this country, there is reason to believe that human infections from this source are far more common than was heretofore recognized. The serum of persons infected with Brucella agglutinates the specific micro-organisms in high dilutions, and such agglutination tests are therefore of value in diagnosis.

When the bacteriology of these infections was better understood, medical writers dropped the terms "Malta fever," and "Mediterranean fever," using instead the term "undulant fever" to describe the clinical condition, and following this by the word "melitensis" or "abortus" to indicate the causative germ. Today the infections with these germs are preferably spoken of as "brucellosis."

Preventive measures will depend on the type of undulant fever encountered. Primarily, to be sure, the problem is one for veterinarians. In order to prevent the spread of infection through milk to humans, pasteurization of milk supplies should be insisted upon.

CHAPTER XI

DYSENTERY AND CHOLERA

DYSENTERY

The term "dysentery" is often rather loosely used to describe intestinal inflammation associated with the discharge of mucus and blood in the stools. It is well to recognize, however, that there are two distinct varieties, namely, *bacillary* and *amebic* dysentery.

Bacillary dysentery is due to infection with one of several closely related types of bacilli known as dysentery bacilli, of which the Shiga, the Sonne, and the Flexner types are the most common. The newer nomenclature groups these dysentery bacilli into a genus called *Shigella.*

Amebic dysentery, common in the tropics, results from infection with an ameba known as *Entamoeba histolytica.* Unlike bacillary dysentery, the amebic variety is often a chronic infection, marked by frequent relapses and sometimes followed by a dangerous infection of the liver known as "amebic abscess."

Since the causative organisms of both forms of dysentery are present in the stools, we see that, as in typhoid fever, we are dealing with excreta-to-mouth infections. Under these circumstances the prevention of dysentery resolves itself into scrupulous cleanliness, protection and purification of water supplies, the avoidance of raw food which may possibly have become infected, the usual precautions against flies and vermin, and the sanitary disposal of stools. In both forms of dysentery, carriers are known to occur; hence precautions against possible infection from this source should not be neglected. In the case of ameba carriers, irrigation of the bowel with solutions of quinine or silver nitrate has been advocated.

In general, the prophylactic measures discussed under ty-

phoid fever must be employed, modified, to be sure, to suit the nature of the infecting micro-organism.

CHOLERA

The home of true cholera is the delta of the Ganges, hence it is usually called "Asiatic cholera" to distinguish it from other cholera-like diarrheal diseases. In India cholera is spread largely through the many religious pilgrimages made by the natives, and the practice of bathing in the holy waters of the Ganges. Thousands of people are thus brought together under most unsanitary conditions. Despite the occurrence of widespread epidemics of cholera in India in the sixteenth, seventeenth and eighteenth centuries, Europe remained free from the disease until the beginning of the nineteenth century. In the past century, however, four pandemics have swept over Europe and have spread even to this country. In 1892, while cholera was epidemic in Hamburg, several cases were brought to New York by transatlantic liners and subsequently a few other cases were discovered in the city. Further spread of the disease was prevented by energetic action of the health authorities. It is worth recording that the appearance of the cholera menace led the city government to establish the bacteriologic laboratory of the New York City Department of Health, the first instance in the world where this diagnostic aid was inaugurated as part of the work of a municipal health authority.

The causative micro-organism of cholera is the *vibrio comma,* or "comma bacillus," discovered by Koch in 1884. It grows well on ordinary culture media even at room temperature, and can also multiply in water. This fact is very important in considering the manner in which the disease is spread. Unlike the typhoid bacillus, the cholera bacillus does not penetrate deep into the wall of the intestine, but produces an intense poison while multiplying in the intestinal contents. There is profuse diarrhea, and the stools contain enormous numbers of cholera bacilli.

Cholera is spread chiefly by contaminated water used for drinking, cooking and washing. Vegetables washed in infected water, particularly lettuce, cress, and the like, may convey

the disease. In the Orient where human excreta are extensively used as fertilizer on land the possibility of cholera infection

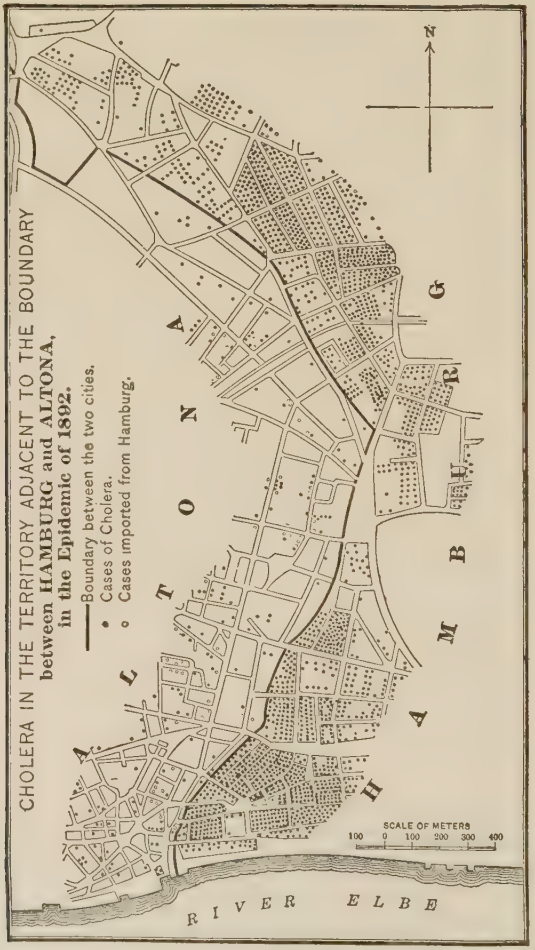

CHOLERA IN THE TERRITORY ADJACENT TO THE BOUNDARY
between HAMBURG and ALTONA,
in the Epidemic of 1892.
Boundary between the two cities.
Cases of Cholera.
Cases imported from Hamburg.
N
ALTONA
HAMBURG
SCALE OF METERS
100 0 100 200 300 400
RIVER ELBE
Courtesy of John Wiley & Sons
The two cities are practically one, the only sanitary difference in 1892 was that Hamburg used the unfiltered water from the Elbe and Altona filtered it.

Fig. 42.—Cholera in Hamburg, 1892; a lesson in water filtration.

from this source must be borne in mind. The almost exclusive use of freshly prepared tea as a beverage has undoubtedly been a safeguard to the people of these countries, and one

may speculate as to whether the drinking of brandy and soda by Europeans in the Orient may not have had a similar value by minimizing the consumption of polluted water.

Carriers of the cholera vibrio, though not as frequently observed as typhoid carriers, are known to occur, and at times may constitute the most common factor in spreading the disease. The carrier condition is not persistent, as is often the case in typhoid infections.

From what has been said of cholera, it will be clear that, in general, the preventive measures against typhoid infections discussed in the previous chapter are applicable to cholera. A bacterial vaccine consisting of dead cholera vibrios has been used for protective immunization in India and Japan with considerable success.

CHAPTER XII

DIPHTHERIA

We come now to a type of communicable disease quite different from those we have been considering, namely, diphtheria. The oldest clear description of this disease is that of Aretaeus (100 A.D.), but accounts of a disease bearing strong resemblance to diphtheria go back to 400 to 500 B.C. It is characteristic of the low state of culture during the Middle Ages that no accurate description of the disease was given in

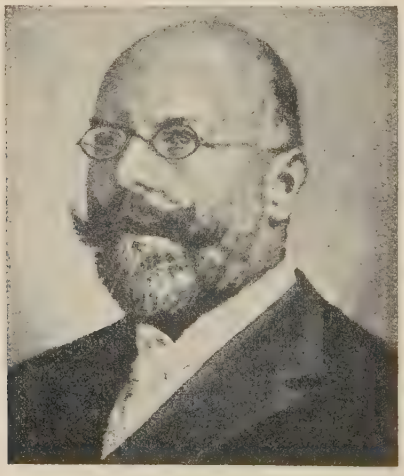


Fig. 43.—Friedrich A. J. Löffler (1852–1915).

that period, but important epidemics were recorded that undoubtedly were diphtheria.

It was not until about a century ago that diphtheria was distinguished from other diseases associated with marked inflammation of the tonsils, especially from scarlet fever and quinsy.

The name "diphtheria" was first given to the disease by Bretonneau (1821), but the term was only gradually adopted by the medical profession. Thus in New York City the first

death to be recorded under this name was in 1857. Before that time the physicians' certificates for such deaths recorded them as due to "croup," or "suffocative angina," or "inflammation of the throat," or other designation.

Prior to the days of medical bacteriology the diagnosis of diphtheria could, of course, be made only by clinical observation, in which the characteristics of the "false membrane" in the throat played a chief part. While this is still highly important, a correct diagnosis is now greatly aided by the microscopic examination of the membrane for diphtheria bacilli.

Causative Agent.—The essential cause of diphtheria is the bacillus first demonstrated microscopically by Klebs in 1882 and first isolated in pure culture and studied by Löffler in 1883. For this reason it is usually spoken of as the "Klebs-Löffler bacillus" (in the newer nomenclature, *Corynebacterium diphtheriae*). The bacilli are found in the false membrane which characterizes diphtheria infections, but they do not penetrate deeply into the body. Multiplying at the site of infection, on the tonsil, in the nasal passages, or in the larynx, the bacilli give off a powerful poison spoken of as *diphtheria toxin*. The absorption of this toxin gives rise to the constitutional symptoms, the fever and the paralyses, and is the cause of death in many of the fatal cases. When the diphtheria inflammation involves the larynx the condition is spoken of as "membranous croup." This is often fatal because the diphtheritic false membrane may cause suffocation of the patient. Formerly such patients were saved from death by the prompt performance of tracheotomy, or by "intubation," *i.e.*, the insertion of a suitable silver cannula into the larynx. Nowadays the false membrane is removed from the larynx by a suction apparatus.

Incidence and Mortality.—Diphtheria is a disease of children, the large majority of cases occurring in children under ten years of age. It is rare in young infants and in adults. Before the introduction of antitoxin treatment, diphtheria was attended by a high mortality, averaging from 30 to 40 per cent. Where the larynx was involved ("croup") the mortality was almost 100 per cent. In contrast to this, during the five years 1935–1939 the contagious disease hospitals of the city of New York treated 1895 cases of diphtheria, includ-

ing many cases of croup, with a case fatality rate of only 6.5 per cent.

Mode of Spread.—The disease is spread by means of infected throat and nasal discharges, and the transmission may be quite direct, though occurring in many different ways: transmission, for example, through infected objects such as toys, dishes, spoons, towels, napkins, handkerchiefs and articles of clothing. Droplet infection, too, is frequent.

Healthy *carriers* of diphtheria bacilli may cause the infection of others, and such carriers undoubtedly account in a large measure for the occurrence of the disease among persons who have not been in direct or indirect contact with another case of diphtheria.

Diphtheria bacillus carriers are of special significance when they occur among school children. Most statistics regarding their prevalence in this group are unreliable, for they are usually based only on the microscopic examination of throat cultures. Unfortunately, in many throat cultures one often finds bacilli which have the morphology and staining characteristics of true, virulent diphtheria bacilli, but which, when tested further are absolutely nonvirulent. They are generally spoken of as "diphtheroids," and have no significance whatsoever in the spread of diphtheria.

How misleading a picture of the prevalence of normal diphtheria carriers is obtained when the findings are based only on the microscopic examination of throat cultures is well illustrated by a careful survey reported by Fraser and Halpern:* Of 12,560 cultures taken of school children in Toronto, 1934–1939, 88 showed bacilli which on the basis of microscopic examination appeared to be diphtheria bacilli. Of these 88 only 5 proved to be true diphtheria bacilli by virulence tests. The rest were diphtheroids.

Not infrequently these diphtheroids cause annoying delays in releasing from isolation those who have just suffered an attack of true diphtheria, for it is the practice of most health authorities not to release a diphtheria convalescent from isolation until after two successive cultures from the nose and throat show no diphtheria bacilli. Usually this requires a

* "Diphtheria Studies in Toronto," Diphtheria Supplement, Am. Jour. Pub. Health, March, 1940.

week or two after the termination of the disease. In some cases the microscopic findings are still "positive" after three or four weeks, and then the question arises whether the bacilli seen under the microscope may not be merely "diphtheroids." The laboratory must then isolate the suspected bacilli and subject them to a "virulence test," by means of animal inoculation. Actually, in a large proportion of cases, the bacilli are found to be nonvirulent, so that the convalescent patient may be released from isolation.

Fig. 44.—Bela Schick.

Susceptibility.—Not all children are susceptible to diphtheria. By means of an ingenious test devised by Schick in 1913 we now have a simple method of determining whether or not an individual is susceptible to infection. The *Shick test* is made by injecting a very small amount of diphtheria toxin, *i. e.*, the diphtheria poison, *into* the skin (not *under* the skin). If, within forty-eight hours, there is no reaction at the site of injection, it indicates that the individual has antitoxin in the blood, *i. e.*, he is immune. If, however, within forty-eight hours there is a red, inflamed area which by the end of a week changes to a brownish discoloration of the skin, slightly larger than the wheal made at the injection,

the individual is susceptible. This staining persists from one to ten weeks but eventually disappears entirely.

As a result of tests carried out by Park and his co-workers on 20,000 persons, the following percentages of susceptible individuals at the different ages may be given:

Age.	Percentage susceptible.
At birth	10 per cent or less
Under 4 months	15 " "
Four to 6 months	30 " "
Six to 9 months	60 " "
Nine months to 1 year	75 " "
One to 2 years	75 " "
Two to 3 years	65 " "
Three to 5 years	40 " "
Five to 10 years	30 " "
Ten to 20 years	25 " "
Over 20 years	20 " "

It will be noted that at birth 90 per cent of the children are immune to diphtheria. This is undoubtedly due to the inheritance of antitoxin from the mother, especially through breast nursing during the early weeks of infancy. This inherited stock of antitoxin is gradually lost and the proportion of susceptible children increases, so that at the end of the first year 75 per cent of the children are susceptible. When one considers that the death rate from diphtheria among older children and adults is very much lower than in young children, it is at once clear that our efforts must be concentrated on preventing diphtheria infection in young children, especially in children from nine months to ten years of age.

Treatment.—In 1893 von Behring announced that an antitoxin he had discovered could be used successfully in the treatment of diphtheria. Within a very short time this specific remedy was universally adopted, with the result that the mortality from diphtheria was markedly reduced.

In using antitoxin in the treatment of those ill with diphtheria, it is important to administer the serum as early in the disease as possible. Each day's delay increases the death rate. This is well brought out in the accompanying graph.

Immunization.—It was found that not only was the serum useful in treating those ill with the disease, but that injections of it into those who were in close contact with diphtheria

protected against infection. Such injections are spoken of as "immunizing" injections. (See also page 41.)

Fig. 45.—Emil von Behring (1854–1917).

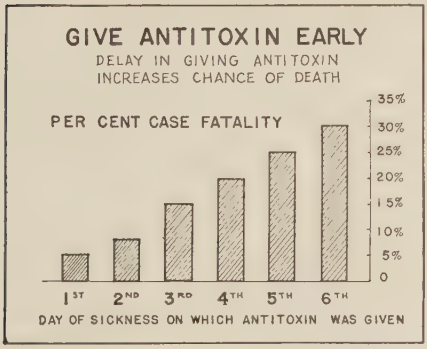


Fig. 46.—Diagram showing the percentage of deaths in 20,794 cases of diphtheria, classed according to the day of the sickness on which antitoxin was given. With each day's delay in giving antitoxin the danger increases. (From Williams, Personal Hygiene Applied.)

Although the introduction of antitoxin marked a definite step in the control of diphtheria, it did not give complete

mastery over this dread disease of childhood. Experience showed that the protection afforded by the immunizing injections did not last long, the protective effect wearing off, as a rule, within a month or two. Careful laboratory studies showed that this was partly due to the fact that the antitoxin injected was *horse* serum, *i. e.*, a serum foreign to the human

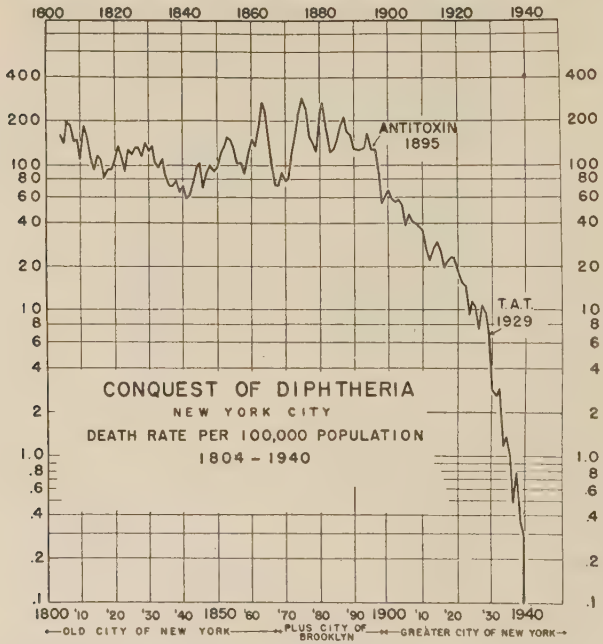


Fig. 47.—The mortality from diphtheria in New York City since 1804. Note the effect of the introduction of antitoxin in 1895, and of extensive active immunization in 1929. Diphtheria deaths in 1895 numbered 3630; in 1929 there were 463; in 1940 only 10.

body. Further experiments, on animals, however, showed that even when the antitoxin was derived from the same species of animals, *e. g.*, guinea-pig antitoxin injected into guinea-pigs, the protection thus conferred passively was not lasting.

In 1905 Theobald Smith suggested that human beings might be made immune to diphtheria by injecting them with

small doses of diphtheria *toxin,* but so many difficulties presented themselves that the suggestion was not acted upon Von Behring and some of his associates subsequently attempted to immunize human beings by means of a toxin which had been particularly neutralized by antitoxin. Their results, published in 1913, while incomplete, were on the whole favorable. The World War compelled Behring to give up further studies along this line. At this point the work was taken up by Park and his co-workers at the Research Laboratory of the New York City Department of Health. They perfected the method, fixed the dosage, and determined the optimum degree of neutralization and the age at which children should be immunized. At first, immunizations were done only on children giving a positive Schick test. Nowadays the immunizing treatments are usually given to all young children, preferably about the ninth month of life. In order to determine whether the treatments have brought about immunity, a Schick test may be made several months after the last immunizing injection.

In place of a mixture of toxin and antitoxin as originally perfected by Park, diphtheria *toxoid** is now extensively used. Toxoid is a modified nonpoisonous form of toxin, prepared by adding formalin to diphtheria toxin and allowing the mixture to stand about a month. The addition of the formalin causes the toxin to lose its poisonous quality, while the immunizing qualities remain. Experience has shown that this toxoid is a more effective immunizing agent than is the toxin-antitoxin; in older children it does, to be sure, more often cause sore arms.

For purposes of immunization against diphtheria, three injections of toxin-antitoxin, or two to three of toxoid are usually given preferably at intervals of a month. The immunity takes from one to three months to develop, and generally lasts for several years. When children have been successfully immunized in infancy, a considerable proportion will be found to have lost their immunity when they are five years of age, and about to enter school. Experience has shown that in these children a single small dose of toxoid will promptly restore the immunity to a satisfactory protective level. Ac-

* A toxoid prepared by Ramon in France is spoken of as "anatoxin."

cording to Fraser of Toronto, this reinforcing injection need not be larger than 0.1 cc. of toxoid.

Because of the time required to bring about immunity, one must not employ this form of immunization to protect children who are exposed to a patient ill with diphtheria. For such children immunizing injections of diphtheria *antitoxin* must be used as heretofore. After the danger is passed, however, the children may be actively immunized with toxoid in order to bring about lasting immunity.

The graph (Fig. 47) showing the influence of active immunization on diphtheria in New York City is typical of what has happened wherever a large proportion of the child population has been immunized. It should be noted that in New York an intensive immunization campaign was begun in January, 1929. At present over 75 per cent of the preschool population has been effectively immunized.

CHAPTER XIII

SEPTIC SORE THROAT. SCARLET FEVER

SEPTIC SORE THROAT

Septic sore throat is an infection of the tonsils and pharynx caused by a virulent streptococcus, associated with marked symptoms of septic poisoning, and often running a very severe course. The infection is always derived from a previous human case, though it is frequently transmitted through milk which has been infected from such a case. The streptococci derived from bovine sources, for example, those which enter the milk from an infected teat, differ from the streptococci found in septic sore throat and do not give rise to this condition.

Septic sore throat appears at times in severe epidemic outbreaks, and may be attended by a high mortality. Some of the outbreaks have even been transmitted by pasteurized milk, the milk having been infected by an individual suffering from the disease who handled the milk after pasteurization. Such instances indicate the importance of a rigid supervision of all persons handling milk.

SCARLET FEVER

Scarlet fever is an acute infectious disease characterized by fever, sore throat, and a diffuse bright red rash. Subsequently there is a characteristic flaky peeling of the skin. The usual incubation period is three or four days, but may be as short as twelve hours and as long as ten days. The disease often appears in epidemic form, especially in infant asylums and other child-caring institutions.

Mortality.—The mortality from scarlet fever varies in different epidemics, at different times and in different parts of the world. Sixty or seventy years ago the average case fatality ranged from 10 to 15 per cent, but in recent years it has generally been less than 1 per cent in the United States.

Although there is reason to believe that scarlet fever prevailed in Europe for centuries, the disease was first clearly recognized and described by the great English physician Sydenham in 1676. Prior to that time it was often confounded with measles and smallpox. It is worthy of note that although until very recent times no specific remedy was available for the treatment of scarlet fever, the death rate from this disease has greatly decreased in the last thirty-five or forty years. Although this reduction corresponds in point of time to the period in which the discoveries in bacteriology focused greater attention on the human sources of infection, it would be a mistake to assume that it was brought about by preventive measures. It is very probable that the disease is becoming milder in type, a phenomenon observed in a number of other infectious diseases, *e. g.*, syphilis. This assumption finds indirect support from the fact that although the death rate has steadily decreased in the past thirty or forty years, we now know that no really effective administrative measures were available for the control of the disease. The recent advances in our knowledge of scarlet fever make us realize that many of the measures employed were misdirected, for they were based on the assumption that the disease was spread by the peeling of the skin which follows the rash. It is almost certain that the peeling skin plays no part whatever in transmitting the disease.

Causative Agent.—The intensive research work of recent decades, especially the studies of G. F. Dick and Gladys H. Dick, leave no room for doubt that scarlet fever is caused by the poison of certain varieties of Streptococcus pyogenes spoken of as *hemolytic streptococci* because they have the power to dissolve the red blood cells. The micro-organism itself causes the inflammation of the throat and tonsil, the rhinitis, the infection of the middle ear, the suppurating glands; the toxin is responsible for the rash, the constitutional symptoms, and perhaps also for the nephritis which so often develops.

Susceptibility and Immunity.—The toxin of the hemolytic streptococci can be used to test the susceptibility or immunity of individuals. For this purpose it is injected intradermally in the same manner as that employed in the Schick test. This

method of using the toxin is known as the *Dick test.* If the individual is susceptible, *i. e.,* if he has no scarlet fever antitoxin in his blood, there is a characteristic area of redness at the site of injection after from twelve to twenty hours. In the case of immune individuals the reaction is negative, that is to say, there is practically no change at the site of injection.

It can be shown that the serum of a convalescent from scarlet fever contains a specific antitoxin capable of neutralizing the scarlet fever toxin. Moreover, and this is of great practical importance, it is possible to immunize horses by means of repeated injections of the toxin and to use the antitoxic serum thus produced in the prevention and treatment of scarlet fever.

The presence of antitoxin in the blood serum (human or horse) can be demonstrated in either of two ways: (1) the serum, added to a toxin solution double the strength used for the Dick test, will neutralize the action of the toxin so that no reaction will be produced when the mixture is injected intradermally into a susceptible individual; (2) the serum, injected in a dose of 1 cc. intradermally into the rash of an early case of scarlet fever, will blanch the rash over an area the size of a twenty-five-cent piece or more. This latter reaction is spoken of as the *Schultz-Charlton phenomenon.*

Our whole conception of scarlet fever has been revolutionized by the discoveries just outlined. We now regard scarlet fever as analogous to diphtheria in that its chief symptoms are due to the poisons absorbed from the germs growing in the throat. Scarlet fever differs from diphtheria, however, in the tendency of the hemolytic streptococci, *i. e.,* the germs themselves, to invade the body and produce gland, ear, joint and other infections. It is important to realize, moreover, that when a person convalesces from scarlet fever he acquires an immunity only against the *toxin* of the specific hemolytic streptococcus, but not against the bacterium itself. In other words, although he will not again have an attack of "scarlet fever," he may at any subsequent time acquire infections due to the hemolytic streptococcus. These reinfections, however, are not associated with the characteristic clinical sign of scarlet fever, a rash followed by desquamation (peeling). Furthermore, when so reinfected with the hemolytic strepto-

coccus, such an individual may transmit typical scarlet fever to susceptible individuals. We can now understand why purulent discharges in a scarlet fever convalescent, *e. g.*, a running ear or a suppurating gland, will so frequently spread scarlet fever to others, and why there is no danger of spreading the disease through the peeling skin of such convalescents.

Treatment.—Several types of scarlet fever serum are now being prepared, some produced in response to inoculations of *toxic filtrates alone,* others in response to inoculation of *toxic filtrates* and *whole* cultures of streptococci. It is possible that the latter may be more effective, but it is still too early to say. Even at present, however, the use of the antitoxic serum in the treatment of severe toxic cases marks a great advance in dealing with this disease. Where animal antitoxic serum is not available, good results will also be obtained with the serum or citrated whole blood from convalescents as well as from individuals who give negative Dick reaction. In fact, the serum of convalescents is preferable to the antitoxic serum prepared from immunized horses, for, being of human origin it does not give rise to serum rashes, often an annoying and disturbing accompaniment of the horse serums.

Control Measures.—Heretofore, the preventive measures against scarlet fever resolved themselves into isolation of the patients and the strict observance of precautions to prevent the transmission of the infection to other susceptible individuals. We now know that the matter is not so simple, for we realize that persons who are not ill with scarlet fever may harbor the causative hemolytic streptococci. The Dicks and a number of other investigators advocate the active immunization of healthy young children by means of injections of scarlet fever *toxin.* Some have tried scarlet fever *toxoid.* This is analogous to the active immunization of children against diphtheria but, when immunizing against scarlet fever, a considerable number of injections of toxin are necessary and these may at times produce reactions as severe as an attack of scarlet fever. The reported experiences with such active immunization are contradictory and still the subject of much controversy. Certainly the procedure has not been nearly as successful as has that against diphtheria.

CHAPTER XIV

PNEUMONIA, INFLUENZA, COMMON COLDS, WHOOPING COUGH, PSITTACOSIS

PNEUMONIA

Among the infectious diseases the one that, year in, year out, takes the greatest toll of human lives is pneumonia (inflammation of the lungs). The term "pneumonia" is a clinical designation and not a bacteriologic one, for inflammation of the lungs may be caused by a number of different micro-organisms such as the pneumococcus, the influenza bacillus, the bacillus of Friedländer and the bacillus of plague.

By far the most prevalent and most important form of pneumonia, "lobar pneumonia," is caused by the *Diplococcus pneumoniae,* commonly called the "pneumococcus." This micro-organism was first described by Sternberg in 1880 and later carefully studied in cultures by Fränkel. In pneumonia there is a marked pouring out of leukocytes, serum and fibrin into the air spaces of the lung. Mixed with this are degenerated epithelial cells from the tissues surrounding the air spaces, red blood cells, pneumococci and cell débris. The affected lobe becomes almost solid and may be compared to a sponge which has been saturated with pus. There is much absorption of poison from all this material, hence the high fever, delirium and rapid pulse. The pneumococcus is found in large numbers in the consolidated lobe and in the sputum coughed up by the patient. The disease is spread from person to person both by direct transfer of this germ-laden sputum and by droplet infection. Although it is probable that pneumococci are present in the throat of most healthy persons, these germs are usually less virulent than those in the sputum of a patient ill with pneumonia. The pneumonia patient, therefore, constitutes the chief source of infection to be considered in devising preventive measures.

In view of the wide distribution of the pneumococcus and the frequency with which most of us probably come in contact

with it, without developing pneumonia, it is clear that man must possess a certain degree of resistance to infection with this micro-organism. We know hardly anything of the nature or mechanism of this immunity, but we do know of a number of ways in which this resistance can be diminished. Over-indulgence in alcohol, exposure to cold, sudden changes of temperature, injury, especially injury caused by the aspiration of foreign substances, the inhalation of dust or irritant vapors—these are some of the more important factors favoring the development of pneumonia. In children the injury done to the bronchial mucous membranes by an attack of measles often leads to the development of pneumonia. The debility due to old age is a common predisposing factor.

We usually speak of the pneumococcus as if it were a very definite and distinct micro-organism, but careful bacteriologic studies have shown that the pneumococci are not all alike, and that a number of different varieties must be recognized. This was first clearly pointed out by Cole and Dochez, who described three distinct *types* of pneumococci, all the rest being designated as "Group IV." Since that time about thirty additional distinct types have been identified, the late Miss Cooper of the Research Laboratory of the New York City Department of Health having been one of the most prolific contributors to our knowledge in this field. The relative prevalence of the different types varies from time to time and with locality.

Until recently the determination of the type of pneumococcus present in a given case of pneumonia was a difficult laboratory procedure. Now, however, the procedure devised by Neufeld in 1902, and then apparently forgotten until a few years ago, makes the determination a simple matter.

The importance of knowing the type of pneumococcus involved in any particular case of pneumonia arises from the fact that effective antiserums are available for the treatment of a number of these types. As a rule the sera are so specific that they are of value only for their particular type and not for another.

Stimulated by the excellent results obtained by sulfanilamide in the treatment of streptococcal infections, research chemists have produced somewhat similar compounds belong-

ing to this group of "sulfonamides." Among these, sulfapyridine and sulfathiazole have great value in the treatment of pneumonia. They have the advantage of acting on practically all the different types of pneumococci and are therefore extensively used as a first step in treatment, before the results of sputum typing can be obtained. Many cases respond quickly to chemotherapy alone; in others serum treatment is also required.

A number of progressive health departments now require the reporting of all cases of pneumonia and properly regard the disease as one of the communicable diseases for which preventive measures should be prescribed. If the patient is treated at home some authorities advocate placarding the premises in order to discourage visiting and also as an educational measure. The patient should be kept isolated and all precautions should be taken to prevent the dissemination of germ-laden sputum. The sputum should be collected in paper napkins which can be burned, and care should be taken that, in coughing, particles of sputum are not sprayed into the air. In crowded rooms the inhalation of such moist particles of spray by others is undoubtedly a source of danger. Patients suffering from pneumonia are often too ill to prevent the soiling of their lips, face and hands with sputum and thus create another source of infection.

It is encouraging to know that the pneumococcus is very sensitive to germicidal agents. Exposed to direct sunlight the pneumonic sputum loses its infectivity after a few hours. When expelled in coughing, the fine spray remaining suspended in the air usually dries so completely that no pneumococci survive after two hours.

In dealing with an excessive prevalence of pneumonia in labor camps, and the like, attention should be paid to the prevention of overcrowding. Prevention, in such cases, consists in scattering the workmen and giving them separate homes instead of barracks. Gorgas used this plan with great success in reducing the prevalence of pneumonia among the workmen in the mines of South Africa.

INFLUENZA

Influenza, also called grippe, is an acute, highly communicable infection of the respiratory tract. It usually occurs

in sudden, sharp epidemic outbreaks which run like wildfire through a community within five or six weeks, and then subside as quickly as they appeared. A characteristic of the disease is the frequency with which it spreads quickly over large areas, entire continents or even the entire world. Such large epidemics are spoken of as "pandemics."

Although epidemics of influenza were described by various writers in the Middle Ages, the clearest accounts we have prior to 1918 are those of extensive epidemics in Europe during the eighteenth and nineteenth centuries. No other disease spreads so rapidly or so extensively. During 1918 practically the entire world was invaded within the space of a few months. The death toll was enormous. At least ten great pandemics have been recorded—1510, 1557, 1580, 1729 to 1732, 1780 to 1782, 1830 to 1833, 1836 to 1837, 1847 to 1848, 1889 to 1892, and 1918 to 1920.

During the pandemic in 1889 to 1892, Pfeiffer, in Germany, isolated a small bacillus which he claimed was the specific causative factor. This "influenza bacillus," as it was called, was generally accepted until 1918, when much doubt was thrown on its rôle in influenza, and this led scientists to begin investigations along new lines.

For years these studies were hampered by the failure to discover suitable animals which could be used for experimental purposes. Then came the discovery that ferrets could be infected with the nasal and lung secretions of persons ill with influenza, and that from these ferrets other laboratory animals, such as mice, could be infected. The vast amount of experimental laboratory work thus initiated has shown conclusively that influenza is caused by a filtrable virus. Moreover, it is now a relatively simple matter to grow this virus on culture media containing living animal cells. Vaccines made from cultures of the virus have been tried as preventives of influenza, but thus far the results have not been satisfactory. This is not surprising, because an attack of influenza appears to give only a transient immunity which tends to disappear after a few months. Recent studies have disclosed that there are several types of influenza virus, though there is no difference in the clinical picture produced by the different types.

In the northern hemisphere most epidemics of influenza

occur in the first quarter of the year, often beginning late in December. They strike suddenly, the number of cases rising

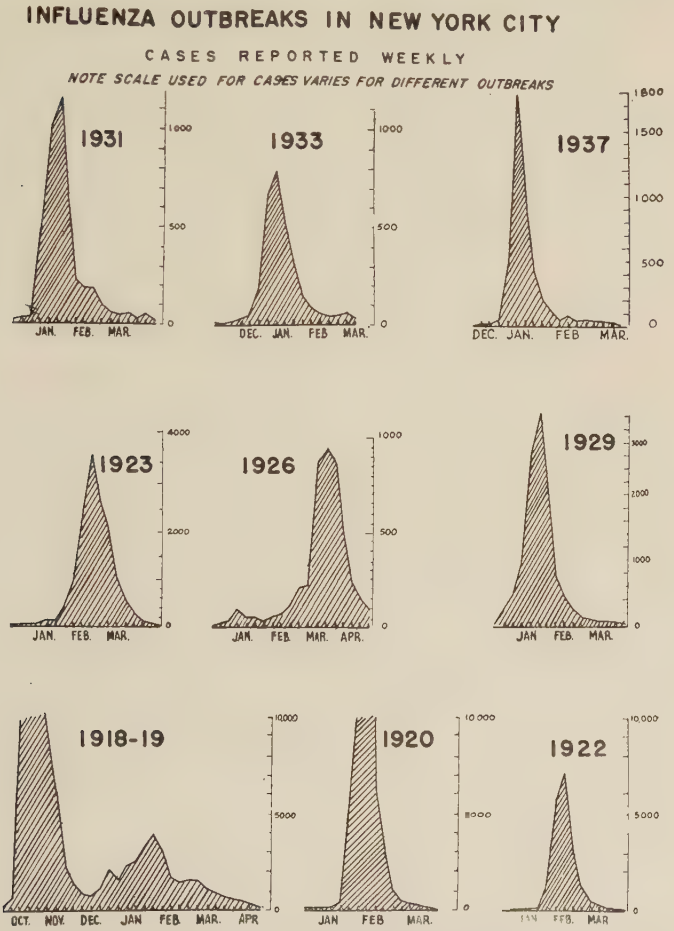


Fig. 48.—Explosive character of influenza outbreak. Note the fairly uniform duration of the explosions.

rapidly and usually reaching their peak in about three weeks, when they decline with equal rapidity. From a clinical standpoint it is practically impossible to distinguish an individual

case of influenza from a common cold with fever. The health administrator watching the mortality returns can, however, often recognize an outbreak of influenza by its explosive character, and by the increase in the general death rate, for the number of deaths reported as due to influenza is always only a small part of the increased number of deaths (above the normal expectancy) which occur during the six or seven weeks of a typical influenza outbreak. An increased prevalence of common colds does not show this explosive character; the common cold spreads more slowly, it has not so marked an effect on the general death rate, and it does not terminate so abruptly.

That the problem of influenza has not yet been solved is indicated by recent experiences, both in this country and abroad, with epidemic outbreaks having some of the epidemiologic and clinical features of influenza but in which it was not possible to discover the presence of the influenza virus. It has been suggested that there may be different types of influenza virus, or that other causative agents may also be involved.

The virus is present in the secretions of the nose and throat of the patients. Precautionary measures should be the same as those adopted against other respiratory infections. These measures include isolation of the sick, strict observance of aseptic nursing, sterilization of dishes, and the like. It must be admitted, however, that even these measures appear thus far to have had little influence on the spread of the disease. We need much more scientific knowledge regarding the manner in which the virus is spread.

COMMON COLDS

That common colds are often highly communicable is well known. Studies by Kruse in 1914, subsequently confirmed by Foster, showed that a filtrable virus could be obtained from common colds, and that this would reproduce the disease. Whether this represents the specific micro-organism of the infection, or whether other organisms, producing similar infections, are frequently responsible for common colds, is not yet established.

We know enough, however, to insist that all common colds

be regarded as dangerous foci of infection, especially to infants and young children.

Preventive measures will be similar to those employed against respiratory infections in general. Their application, to be sure, is more difficult, for the infections are rarely severe enough to confine the patient to bed, and experience shows that it is just these ambulant (walking) cases that are most likely to spread infection. Education of the public to teach them the communicable nature of colds and the necessity of "covering up each cough and sneeze" is important. Bacterial vaccines for the prevention and treatment of colds have been tried extensively, but in all properly controlled demonstrations the results have been unsatisfactory. The same is true of treatment by inhalation of chlorine.

WHOOPING COUGH (Pertussis)

Whooping cough is a catarrhal infection of the upper respiratory tract characterized by severe paroxysms of choking coughs. The disease is due to infection by a small hemophilic bacillus first described by Bordet and Gengou in 1900.

During the past decade, with the marked reduction in deaths from diphtheria, scarlet fever and measles, whooping cough now occupies first place among the common contagious diseases as a cause of death.

The disease is transmitted from person to person by infected discharges sprayed into the air, the period of greatest communicability being the first two weeks. At this time whooping cough is often thought to be a common cold, the characteristic whoop not yet having made its appearance. Most children are susceptible, one attack usually conferring immunity. In infants and young children the infection may prove fatal.

For years attempts were made by numerous investigators to immunize with some form of bacterial vaccine, but the results were equivocal. Since 1935 a vaccine prepared according to the direction of Sauer has been widely used and many encouraging reports concerning its value have been published. The evaluation of these reports has led to considerable controversy, and a final decision is not yet possible. Certainly

its immunizing value is not comparable to that afforded by vaccination against smallpox or toxoid immunization against diphtheria.

Sauer recommends that immunization against whooping cough be undertaken during the eighth month of life. This has led a number of investigators to advocate combining in one injection whooping cough vaccine and alum-precipitated toxoid for diphtheria, two or three doses being administered three weeks apart.

PSITTACOSIS (Parrot Fever)

In recent years an intestinal disease occurring in parrots, parrakeets ("love birds") and other birds has been found to produce a severe, often fatal, influenza-like disease in man. The infection is due to a filtrable virus and is highly communicable to man. Laboratory workers have frequently become infected despite the greatest precautions; several of the workers have died.

In guarding against psittacosis one should avoid all contact with sick birds, the possibility that the illness is psittacosis being borne in mind. A severe, grippe-like infection in a person, following shortly after a pet bird has been ill or has died, or following the recent acquisition of a parrot or parrakeet, should lead one to suspect psittacosis. A positive diagnosis can be made only by inoculation experiments on other birds. A complement fixation test has recently been described, which may simplify the diagnosis of this infection.

There is, as yet, no specific treatment for the disease. Patients have been treated with the serum of recent convalescents, but experience is still too limited to warrant an opinion as to the value of such serum treatment.

CHAPTER XV

SEPSIS, ANTHRAX, PLAGUE, TULAREMIA, TETANUS

SEPTIC INFECTIONS

For the student of preventive medicine it is more convenient to consider "septic infection" as a single subject than to take up individual forms of infection from a bacteriologic standpoint. A very large number of the commoner pathogenic bacteria may give rise to septic infection ("blood poisoning"

Fig. 49.—A surgical operation without anesthesia and without asepsis.

of the laity), *e. g.*, the Streptococcus pyogenes, the staphylococcus, the anthrax bacillus, the plague bacillus, Bacillus mallei (glanders), etc.

It will never be possible to estimate the number of lives which must have been sacrificed to septic infection prior to Lister's great discovery of antiseptic surgery. Septic infection, in one form or another, constituted a common cause of death and was the great dread of surgeons during the Middle Ages. This fear of "poisoning" gave rise in the fifteenth century to the barbaric practice of pouring boiling oil into wounds

or burning them out with red-hot irons, a practice which called forth the condemnation of Paracelsus and which was first abandoned by the great French barber surgeon Paré. Childbirth, too, was not only painful, but highly dangerous as well, owing to the frequent occurrence of child-bed fever as the result of septic infection.

These conditions continued to about the middle of the last century. Statistics from the large hospitals in London seventy or eighty years ago showed that the mortality attending amputations ranged from 35 to 40 per cent. During our Civil War the rates were even higher, ranging from 6 per cent

Fig. 50.—Sir Joseph Lister (1827–1912).

mortality in amputations at the wrist, and 13 per cent in amputations at the ankle, to 64 per cent and 85 per cent respectively for amputations at the thigh and hip joint.

Our present knowledge regarding septic infection and the truly remarkable advances made in controlling this condition date from the discoveries made by Pasteur and from the practical lessons drawn from Pasteur's work by Lister (1867). Some time previously, to be sure, both Semmelweis and Holmes had pointed out the manner in which puerperal sepsis (child-bed fever) could be spread, but their contribution to preventive medicine is small compared to that of Pasteur and Lister.

Although many different pathogenic bacteria may produce

septic infection, the micro-organism chiefly responsible is the *Streptococcus pyogenes,* first described by Ogston in 1882. This is probably due to the fact that the streptococcus is often highly virulent and thrives readily in the human body. It is widely distributed, occurring not only in persons infected with tonsillitis, erysipelas, scarlet fever and infected wounds, but also in a large number of normal individuals, especially in the throat. In addition to this, virulent streptococci may be found in milk, especially when a cow is suffering from disease of the udder or teats (*e. g.,* mastitis), in sputum, and occasionally in dust. The *staphylococcus* is even more common, being found in the skin, in dust, and in furuncles (pimples), boils and abscesses. The staphylococci, however, are usually less virulent than the streptococci, and are more apt to give rise to localized infections, such as boils, than to septic infection. In comparison with the large number of cases of septic infection due to the micro-organisms just mentioned, those due to the bacilli of plague and glanders are relatively rare and need not be considered further at this point. Anthrax will be discussed in a following paragraph.

From what has been said, it will be apparent that there are many different ways in which septic infection may develop. Moreover, since we have become familiar with the principles of modern aseptic methods in surgery we can now easily understand why formerly the healing of wounds was almost invariably associated with the production of pus. Before Lister's time, surgeons even spoke of certain kinds of pus as being "laudable pus." By this they meant the thick creamy pus which affected merely the wound and did not cause a general invasion of the body. They dreaded the thin, serosanguineous pus which, experience taught them, rapidly caused an inflammation that spread from the wound to distant parts of the body.

Thanks to the introduction of the antiseptic method by Lister, and to our constantly increasing knowledge of bacterial infections of all kinds, septic infection has ceased to be the important medical problem it once was. There is still, to be sure, a considerable number of deaths charged each year to *puerperal septicemia* and these deserve attention. Undoubtedly a large proportion of such infections is due to too frequent

digital examinations and to operative interference with the course of labor. Many are traceable to criminal abortion, for such abortions are often undertaken under conditions which favor the development of infection. If, in the treatment of wounds, proper precautions are taken against the introduction of the various causative bacteria, septic infection should be reduced to a very small number of cases. For further details the reader is referred to standard textbooks on aseptic nursing.

ANTHRAX

Anthrax is primarily a septic infection of the lower animals, especially of sheep and cattle. It is occasionally transmitted to man, and may be generalized septic infection (woolsorters' disease) or a localized boil (malignant pustule). The infection is caused by a large, spore-bearing microorganism, the *Bacillus anthracis,* first observed by Pollender in 1849. Davaine in 1863 demonstrated by inoculation experiments that this was the essential cause of anthrax. The spores of anthrax are among the most resistant known to bacteriologists and this makes the eradication of foci of infection difficult. Hides from infected cattle, wool from infected sheep, and brushes from the hair of other infected animals are the common vehicles by which infection is transmitted to man. Preventive measures directed against the source of infection consist primarily in the elimination of foci of infection among animals, and in thorough disinfection of all suspected animal material such as hides, wool and hair.

PLAGUE (Pest, Black Death)

Plague is an acute, febrile, infectious disease caused by *Pasteurella pestis* and is characterized, in the *bubonic* form, by purulent inflammation of the lymph glands, in the *pneumonic* form, by a severe, often hemorrhagic form of pneumonia. A *septicemic* form is also occasionally met with; in this the symptoms are those of septic poisoning.

Plague is primarily an infection common to rats and other rodents. From these the infection may be transmitted to man, the transmission being usually effected through the bites of infected fleas from the diseased animal. In the bubonic

and the septicemic forms of the plague the bacilli are locked up in the inflamed buboes or in the blood stream. With ordinary precautions these forms of plague are not liable to spread from person to person. In the pneumonic form, however, the bacilli are readily disseminated by means of droplet infection, and there is great danger of an epidemic spread of the disease.

Plague in man is now so rare in this country that we need not take up the subject in detail. Preventive measures are directed principally to guarding against the introduction of plague-infected rats from countries where the disease prevails. To this end the United States Quarantine Regulations prescribe the systematic deratting of all vessels arriving at American ports and the observance of special precautions in the case of vessels coming from plague-infested ports.

TULAREMIA

Tularemia is a plague-like disease of wild rabbits and other rodents, caused by *Pasteurella tularensis*. The disease affects the liver and spleen, producing small, pin-point abscesses in these organs, and causing the death of the animal. In nature blood-sucking insects, such as ticks, lice, flies and perhaps fleas, are believed to transmit the disease from animal to animal.

Man readily inoculates himself with the infection while dressing infected rabbits, the germs passing through some wound on his hand, resulting in an ulcer on the hand, enlarged glands at the elbow or in the axilla, and a fever which usually confines him to bed for two or three weeks. The case fatality is about 5 per cent.

Tularemia was first described and carefully studied by my friend and former associate, Dr. Francis of the United States Public Health Service, in 1919 and 1920. Since that time the disease has been reported from almost all parts of the United States, from Canada, Japan, Russia and Norway. In Russia the infection was found prevalent among water rats, trapped for their pelts.

In the United States most of the cases have been traced to infected wild rabbits. Out of 1000 wild rabbits offered for sale in Washington, D. C., Francis found 10, or 1 per cent.

infected with virulent Pasteurella tularensis. Cooks, hunters, housewives and market men are often infected in November, December and January, when it is permitted to hunt wild rabbits for food.

Occasionally human cases of tularemia are encountered in which the infection was transmitted by the bite of a "deer fly," or the bite of a tick.

No cases of tularemia have been traced to rabbits bred for market in rabbitries.

Inasmuch as infected rabbits are ill, Francis advises hunters to beware of a rabbit which does not run at their approach. Moreover he urges not using rabbits for food whose liver or spleen shows the characteristic pin-point abscesses. Care should be taken not to cut or scratch the hands when dressing wild rabbits.

TETANUS (Lockjaw)

Tetanus differs from the other diseases considered in this chapter. It is, to be sure, a germ disease which follows wounds, but there is no spreading inflammation as there is in septic infection or in anthrax or tularemia. However, like the other infections already discussed, tetanus is a condition whose prevention and treatment lie chiefly in the hands of the surgeon.

The term *lockjaw* given to this disease by the laity has led to much popular misconception. The impression prevails that victims of lockjaw die because they cannot eat and therefore starve to death. It is true that there may be spasm of the jaw muscles but, if that were all, the patient could readily be fed by a stomach tube. The spasm of the jaws, however, is only part of a cramplike condition which soon spreads to the heart and the muscles of respiration. This, of course, is fatal.

Tetanus, fortunately not a common disease, is greatly dreaded because of its terrifying symptoms (convulsions) and high fatality. The disease is caused by the entrance of tetanus bacilli (*Clostridium tetani*) into wounds, the bacilli remaining at the site of entrance and producing a powerful poison, *tetanus toxin,* which is the cause of the general symptoms.

Although tetanus bacilli occur frequently in street dust,

garden earth, and manure, infection of wounds with tetanus is relatively infrequent. The explanation lies in the fact that the bacillus of tetanus is an anaerobe, *i. e.,* a germ which grows only in the absence of free oxygen. For this reason, too, an open exposed wound is not favorable for the growth of the bacilli. On the other hand, a deep puncture or a badly lacerated wound, especially if other bacteria and dirt are introduced at the same time, often furnishes ideal conditions for the growth of the tetanus bacilli and the production of its powerful toxin. This accounts for the frequency with which tetanus is encountered in war, and in the wounds inflicted by Fourth of July pistols and firecrackers.

When grown under suitable conditions in the laboratory, tetanus bacilli produce a virulent toxin in the culture medium. By injecting this toxin into animals (horses) a potent *antitoxin* can be obtained, and this is successfully used to protect persons against the development of tetanus. As a rule, such protective injections are given to all persons who have sustained deep, lacerated wounds which one fears may have been infected with earth, street dust, or manure.

The serum may also be used for the treatment of developed cases of tetanus, but its success under these conditions is not very striking. The poor results are due to the fact that the symptoms of tetanus do not usually develop until ten to fourteen days after the injury, and in this time the poison has spread through the body and become firmly lodged in the central nervous system. To obtain the most favorable results the antitoxin must be injected in large doses intraspinally by means of lumbar puncture.

Preventive measures against tetanus consist in laying all deep and lacerated wounds wide open and cleaning them thoroughly. Following this an immunizing injection of tetanus antitoxin should be given. Support should be given to all movements which tend to promote "safe and sane" Fourth of July celebrations.

Wounds sustained on the battlefield are often prone to lead to tetanus. It is now common practice to give all soldiers injections of tetanus toxoid in order to bring about an active immunity against tetanus. This procedure is entirely analogous to the immunization of children against diphtheria.

CHAPTER XVI

THE EXANTHEMATA

The exanthemata include smallpox, cowpox, chickenpox, measles, typhus and scarlet fever. The term "exanthem" means a "breaking-out" (plural, exanthemata) and is given to these diseases because in each there is a characteristic breaking-out of the skin. The diseases thus placed together are not all related, and one of them, scarlet fever, has already been separated from the group and placed with the streptococcus infections. In time we shall probably know more about the others and be able to class them also under their causative micro-organisms.

SMALLPOX OR VARIOLA

Until Jenner's time smallpox was a children's disease and was so prevalent that few escaped it. In fact, persons who were not pock-marked were so uncommon that in the eighteenth century we find the London police giving "not pock-marked" as one of the features by which a sought-for-criminal could be identified. Epidemics of smallpox swept over Europe again and again, sometimes carrying off a quarter of the inhabitants. The disease was carried to Mexico by the Spaniards and killed over 3,000,000 people there in a short time. History tells us that of 12,000,000 American Indians, 6,000,000 fell victims to smallpox.

Although smallpox prevailed in China many centuries before the Christian era, and was probably known to the ancient Greeks, the first accurate description of the disease is that of the famous Arabian physician Rhazes, in the ninth century A.D., who distinguished smallpox from measles.

The *causative agent* of smallpox is a filtrable virus. We do not know the precise mode by which smallpox is conveyed. Some observers believe the infection is air-borne. The virus appears to be contained in the skin lesions and in the dried

material of the pustules. The secretions of the mouth and nose doubtless contain the infection. The disease does not seem to be transmitted by insects, but until we know more about the virus it is wise to guard also against this mode of infection.

In most civilized lands, excepting the United States, it is rare, nowadays, to see typical cases of smallpox, but in non-vaccinated individuals they are now and then encountered. In a case of moderate severity in such persons, the skin of almost the entire body is covered with pustules. After recovery each pustule leaves a scar, the pock-mark. When

Fig. 51.—A severe case of smallpox.

smallpox occurs in vaccinated individuals, as it occasionally does, it is in a modified, milder form spoken of as *varioloid.* In this a few discrete pustules are all that develop. A disease prevalent in the West Indies, and variously known as *alastrim* or *Cuban itch,* is a mild form of smallpox.

COWPOX OR VACCINIA

A pox disease of cows, and occasionally transmitted to dairy workers, is of interest to us, for it was through the investigations made by Jenner toward the close of the eighteenth century that it was clearly demonstrated that an attack

of cowpox protects a person against smallpox. Since cowpox is a mild, local disease, Jenner deliberately infected persons with cowpox by introducing a minute quantity of the material from a cowpox into a tiny scratch in the skin of the arm of a healthy person. (See page 20.) He called this procedure "vaccination," from the latin name for cow, *vacca*.

Cowpox is an eruptive, infectious disease occurring naturally in cattle and other domestic animals and occasionally in man. Nowadays human infections with cowpox are almost

1 2

Fig. 52.—Vaccinating by the puncture method. 1, Expelling vaccine virus from capillary tube onto cleansed skin. 2, Making punctures with needlepoint pressed through drop of virus. (Courtesy of Lederle Antitoxin Laboratories.)

entirely limited to the infections artificially brought about by vaccination. From what we have learned about the specificity of various immune bodies, *e. g.*, antitoxins, agglutinins and bacteriolysins, the fact that an attack of cowpox protects a person against smallpox indicates that the viruses of smallpox and cowpox are very closely related. As a matter of fact, both viruses have a common ancestry and have but modified and adapted themselves in the course of time, one to man and the other to cattle. It must be pointed out that the modification of smallpox virus in cattle is such that it is not possible

to change cowpox virus back into smallpox virus. In other words, there is no danger that the inoculation of cowpox virus, *i. e.*, vaccination, will ever give rise to smallpox.

For the *production of vaccine* one selects healthy young calves. These are thoroughly cleaned, the lower part of the abdomen is shaved and washed, after which the denuded clean area is scarified with a series of parallel scratches into which the so-called "seed virus" is rubbed. After four or five days the entire area is covered with a profuse eruption of cowpox. This material is scraped off with a curette and constitutes the crude vaccine pulp. The crude pulp is taken to the laboratory, rubbed through fine sterile wire sieves and mixed with 50 per cent glycerin containing 1 per cent of pure carbolic acid. This glycerinized pulp is next allowed to age, whereby a large reduction in its bacterial content is brought about through the action of the carbolized glycerin. After about a month this finished product, the vaccine, is ready for use.

Vaccination is usually performed by puncturing, scratching or gouging the skin, the site to be vaccinated having been previously cleaned with soap and water, followed by alcohol. Iodine should not be applied. Inasmuch as there is a definite relation between size of the vaccinated area and the degree and duration of the immunity, it is important not to vaccinate in only one small point. If scratching is employed, two scratches, each about ⅛ inch long, are recommended. In puncturing, three or four punctures 1 inch apart may be used (Fig. 52). Three or four days after vaccination a small pustule develops at the site of inoculation, and within the next few days this undergoes a typical development, changing into a vesicle (fifth day), then into a pustule (ninth day), and finally drying to a scab (Fig. 53).

Experience has shown that it is unwise to cover the vaccinated area with shields. After the virus has dried a small sterile dressing is all that should be applied.

The reaction following the introduction of vaccine virus into the skin of the human being depends on circumstances. Thus, in a child which has not had smallpox, the "take" usually runs the typical course from papule to vesicle, pustule and scab.

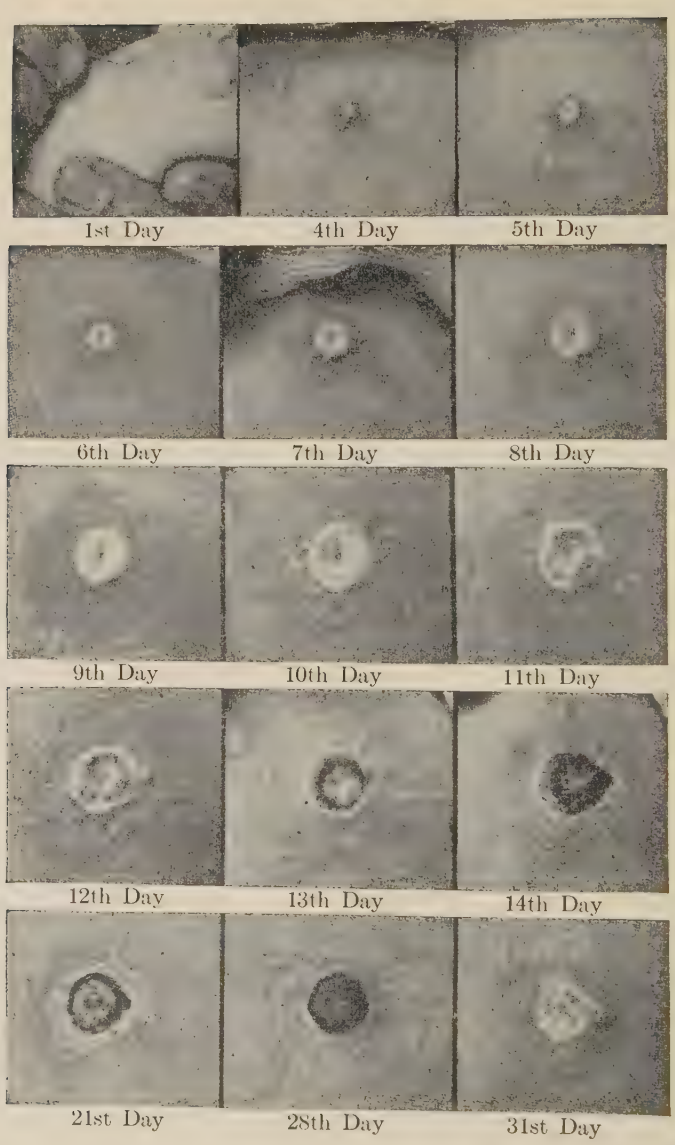


Fig. 53.—The course of the eruption in vaccination. (From Rosenau, Preventive Medicine and Hygiene, D. Appleton & Co., Publishers.)

In persons who have some degree of natural immunity the course is shorter and the lesion less pronounced.

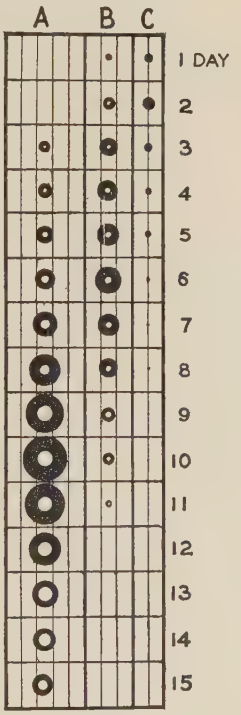
In persons who have been vaccinated recently or repeatedly, the vaccination produces merely a slight papule which disappears in a day or two.

The types of *reaction following vaccination* are illustrated diagrammatically in the accompanying chart.*

A. First vertical column—*Vaccinia or Primary Reaction.*—This is seen in those never previously vaccinated or whose immunity from previous vaccinia or smallpox has completely disappeared. The papule appears on the third day to the fifth day and the vesicle reaches its greatest development on the eighth or tenth day, or later.

B. Middle vertical column—*Vaccinoid or Accelerated Reaction.*—This is seen in those retaining partial immunity from a previous attack of smallpox or a previous vaccination. The papule appears on the third or fourth day, with vesicle formation by the fifth day. Pustulation is frequent. The height of the reaction occurs on the sixth or seventh day, after which it subsides rapidly.

C. Last vertical column—*Reaction of Immunity or Immediate Reaction.*—This is seen in persons possessing a high degree of immunity. A papule appears *within forty-eight hours* and subsides without forming a vesicle.



Wherever vaccination has been thoroughly and completely carried out, smallpox has disappeared. In the United States, where, unfortunately, an active antivaccination campaign has been carried on in many states, smallpox has recently become

* Reproduced by courtesy of the N. Y. State Department of Health, from Health News, 1925, 2, p. 165.

so prevalent that it is a disgrace to our boasted civilization. In fact, a number of communities have suffered outbreaks of virulent smallpox, demonstrating anew the extreme folly, to express it mildly, of permitting fanatics to endanger the public health through their false teachings. Improved hygiene and sanitation are no safeguards against smallpox. Were we to stop all vaccination for a generation we should certainly wit-

Fig. 54.—The infant had previously been vaccinated and did not contract smallpox, despite this close contact with its sick mother.

ness a reappearance of smallpox such as decimated Europe two or three hundred years ago.

CHICKENPOX OR VARICELLA

Chickenpox is one of the minor communicable diseases, usually running a mild course, and attended by a low mortality. Its chief importance lies in the fact that mild cases of smallpox may be mistaken for chickenpox and so lead to an attack of the more dangerous disease.

The cause of chickenpox and its mode of transmission are still unknown. The virus, however, is known to be present in the vesicles constituting the typical eruption.

In dealing with an outbreak of chickenpox in an institu-

tion, one may inoculate the children with material from the vesicles of one of the cases. Eight days later a typical vesicle appears at the site of inoculation. General symptoms are absent. This method has been employed with success.

To prevent the spread of chickenpox it is necessary to isolate the patient until all the vesicles have entirely healed, meantime taking all precautions to prevent contact of susceptible healthy children with anything that may be soiled with infected material.

Since chickenpox is rare in adults, all cases reported in persons over fifteen years of age should be carefully examined by a competent diagnostician to make certain that the disease is not smallpox.

MEASLES

Measles is an acute, highly infectious, febrile disease, characterized by an initial coryza and a rapidly spreading skin eruption. It is an extremely prevalent disease and, while usually regarded lightly, is one of the frequent causes of death in young children.

Published *mortality* statistics give a false picture of the deaths really due to measles, for, although the disease is reportable, the notifications to the health authorities are far from complete. Moreover, in many of the fatal cases a physician has not been called until after the child has developed bronchopneumonia. In such cases the physician enters "bronchopneumonia" as the cause of death and rarely makes any mention of measles. Careful studies by the senior author indicate that in New York City there are two deaths from measles reported merely as bronchopneumonia for each death reported as measles. It is probable that throughout the United States we may multiply the reported number of deaths from measles by three in order to get a true picture of measles mortality. Health officials should bring this home to parents who, far too frequently, regard measles as a trivial disease.

For some reason, not clearly understood, years of high and low prevalence follow each other quite regularly every two or three years, as may be seen from the following table of cases reported in New York City from 1919 to 1930:

Year.	Cases.	Deaths.
1919	8,194	218
1920	35,083	736
1921	7,738	165
1922	40,569	977
1923	13,999	245
1924	33,561	506
1925	9,483	130
1926	39,750	706
1927	2,101	37
1928	35,008	346
1929	2,537	30
1930	23,635	154

Although measles is usually regarded as a disease of children, adults are by no means immune to attacks. In fact, when measles is introduced among people who have never before been exposed to the disease, it quickly spreads and is often fatal. This was the case, for example, during the war among some groups of soldiers enlisted from country districts. Instructive, too, is the fact that in 1775 measles was introduced for the first time in the Hawaiian Islands and there caused 40,000 deaths within four months in a population of 150,000. Similarly in 1874 the introduction of measles into one of the Fiji Islands caused the death of one-fifth of the population in a short time.

The *causative agent* of measles belongs to the class of viruses which are so small that they pass through the pores of a Berkefeld filter, in other words, it is a "filtrable virus." The virus is present in catarrhal nasal and buccal discharges of the infected individual.

Measles begins to be communicable during the prodromal stage of the disease, that is, while the patient is coughing and sneezing and has a running discharge from the eyes and nose. The greatest danger is usually from two days before to five days after the appearance of the rash. The fine scaling following the rash is not a vehicle of transmission.

It is important to remember the long period of incubation of measles—from seven to eighteen days, usually fourteen days. Susceptible children who have been exposed to measles should, therefore, not be allowed to attend school until after eighteen days from the last exposure.

Owing to the frequency with which measles in infants and

young children leads to a fatal bronchopneumonia, special precaution should be observed to avoid exposing such children to infection. When young children *are known to have been exposed* to measles, the intramuscular injection of whole blood from either parent is often advisable. Even better, because a much smaller dose is required, are hypodermic injections of serum from recent convalescents from measles. A number of municipal health departments are now prepared to supply such serum. With parents' whole blood, or with convalescents' serum the injection should be made within the first week after exposure. Even when the disease is not prevented, the injected whole blood or serum lessens the severity of the attack and reduces the liability of the development of pneumonia.

Preventive measures consist in early recognition of the disease, paying special attention to the catarrhal symptoms (coryza) as danger signals, isolating the patient during the period of communicability, and properly disinfecting all articles which may have been soiled with infective discharges.

TYPHUS FEVER AND RELATED DISEASES

The World War furnished an unparalleled opportunity for studying typhus fever, the disease raging in severe epidemic form especially in Serbia. As a result of these and other studies, typhus fever is now regarded as one of a number of infections caused by a new group of micro-organisms called *Rickettsiae.** These are extremely small, bacteria-like bodies, and seem to occupy a place between the bacteria and the viruses. They do not grow on artificial culture media but have been grown in tissue. They stain with difficulty and appear to be micro-organisms primarily adapted to insect tissue. Those so far known appear to have their natural habitat in certain arthropods, such as ticks, lice and bed-bugs.

* So named after Ricketts, who first described such bodies in connection with Rocky Mountain spotted fever, an infectious disease transmitted by the wood tick. Ricketts subsequently died a victim of this disease.

Epidemic Typhus

(Spotted Fever—Jail, Camp or Ship Fever)

Epidemic typhus fever is an acute infectious disease resembling typhoid fever and marked by a characteristic eruption. This accounts for the name "spotted fever." The onset is sudden and the macular rash appears on the third to seventh day; there is a high fever for about two weeks. The mortality varies, but is often high (from 50 to 70 per cent). This form of typhus is usually associated with cold weather.

During the middle of the nineteenth century epidemic typhus frequently decimated the ranks of European emigrants arriving at American ports. The disease prevailed in epidemic form in New York as late as 1893. Except for a few sporadic cases in immigrants, this form of typhus has practically disappeared from the United States.

Epidemic typhus is usually associated with poverty, filth and overcrowding, and the reason for this is now clear, for through the work of Nicolle, we have learned that the disease is spread almost solely by lice. The causative germ exists in the circulating blood of the patient throughout the febrile stage and for a short time after the crisis.

Some experimental work has been done in an endeavor to produce an effective *vaccine* for this disease. These studies showed that immunity to typhus can be given only by actually introducing the living rickettsias into the host. Inoculation with the rickettsia of *louse-borne typhus* is, however, dangerous both to the host, in whom it may cause serious disease, and to the community to which he belongs, because it sets up a reservoir. But there are other varieties and species of rickettsias which produce in man trivial or almost negligible reactions, and whose inoculation brings about an immunity which extends widely for other species. One such almost harmless species is the rickettsia of murine typhus (mouse typhus) which is not spread by lice. Vaccination with murine typhus therefore corresponds to vaccination against smallpox, in that a major disease is prevented by giving a minor one. Thus far such vaccinations have not yet been of practical significance.

For the present, preventive measures against epidemic

typhus still resolve themselves into delousing and other measures directed against infestation with vermin.

The blood of typhus fever patients often agglutinates a certain strain of *proteus* bacilli spoken of as "Bacillus X-19." Employed in the diagnosis of typhus infection this reaction constitutes the *Weil-Felix test*. Inasmuch as Bacillus X-19 is known not to be the causative germ of typhus fever, the reason why the reaction occurs is not understood.

In many European countries the term "typhus fever" is applied to what we call typhoid fever, the designation "spotted fever" or *typhus exanthematicus* being given to the disease under discussion. In compiling statistics from various countries this distinction should be remembered.

Endemic Typhus—Brill's Disease

A mild form of typhus occurring in various parts of the United States but especially in the South, appears not to be related to lice. Investigations by Maxcy, and by Zinsser and others show that rats and other rodents constitute the reservoir of the infection and that it is transmitted to man by fleas and perhaps other insects. To distinguish it from the louse-borne disease described above, it is advisable to speak of this milder form as "endemic typhus."

Another mild form of typhus, originally described by Brill, and occurring especially in cities along the Atlantic Seaboard among Russian and Polish immigrants, is thought to represent a recrudescence of an attack of louse-borne typhus (Zinsser).

Rocky Mountain Spotted Fever

In the northwestern part of the United States a disease is encountered which is apparently closely related to typhus. This is called Rocky Mountain spotted fever, and was so named because it was long thought to be limited to the northwestern part of the United States. It is now known to occur in other parts of this country. Thus it appears to have obtained a foothold in the eastern part of Long Island, the original infection having apparently been introduced by the importation of deer from the West into a game preserve on Gardiner's Island.

The disease is characterized by onset with chill, continued fever, severe pains in bones and muscles, and headache; there is a macular rash, becoming petechial, which appears first on the wrists, ankles and back, then over the entire body. The mortality is high. The western type of the disease is transmitted by the bite of the wood tick, *Dermacentor andersoni;* the eastern type appears to be transmitted by several varieties of ticks, including the dog tick.

Japanese River Fever

Another related disease belonging to this group of Rickettsia infections is one encountered in Japan and called "Japanese river fever" or "Tsutsugamushi disease." This infection is transmitted by a mite, field mice being the reservoir of the virus.

Trench Fever

During the World War a very prevalent epidemic disease affecting the troops in the trenches was "trench fever." It was relatively mild and never fatal. Investigation showed that it was related to the diseases described above and was transmitted by lice. So far as known it does not occur in epidemic form in civil life.

CHAPTER XVII

SYPHILIS, GONORRHEA AND RELATED INFECTIONS

The various infectious diseases about to be discussed are grouped together only for the reason that they are spread chiefly through sexual relations or affect primarily the genital organs. Their respective causative agents are entirely unrelated. Syphilis, for example, is caused by a micro-organism closely related to the spirochetes, the *Treponema pallidum;* gonorrhea is caused by a germ usually spoken of as the gonococcus and bearing the scientific name *Neisseria gonorrhocae;* chancroid, a local ulcerative disease of the genitals is caused by the Ducrey bacillus of soft chancre, now called *Hemophilus ducreyi;* lymphogranuloma inguinale, also at first a local infection of the genitals, is caused by a filtrable virus.

It has been and still is customary to speak of this group of infections as "venereal diseases," but the choice of this designation was unfortunate, for it has led the general public to associate the infections with immorality, an association which has greatly impeded their public discussion. Years of experience with syphilis and gonorrhea, by far the most prevalent of these diseases, have shown that in many cases the infection is innocently acquired and that the designation "venereal" is entirely inapplicable to such cases. In the United States the term "social hygiene" is widely used for the activities against the group of diseases under discussion. This is a misleading euphemism, for "social hygiene" has long been an accepted designation which includes such matters as housing, labor conditions, social welfare, unemployment, old-age pensions and medical care.

Of the group of infections mentioned, syphilis and gonorrhea, because of their enormous prevalence and the invalidism they produce, constitute very important health problems. Various reported surveys indicate that in the

United States from 10 to 20 per cent of the population has or has had syphilis or gonorrhea and that in a large proportion of the cases the infection is still active.

No serious attempt was made by health authorities anywhere to face this situation until, in 1912, New York City, under the leadership of Biggs, determined to treat the venereal diseases as any other highly communicable disease, dealing with the problem purely from a public health standpoint and ignoring the moral and social phases. New York's example has been followed by other health authorities and we are gradually developing a line of attack on these diseases which should lead to their control. It is especially gratifying to note the entrance of the U. S. Public Health Service into the field under the leadership of Surgeon-General Parran. Throughout the nation the public has been roused to the menaces of syphilis and gonorrhea and to the need of concerted action against them. At long last these diseases are discussed publicly and frankly, federal, state and municipal funds are being made available, effective legislation is being enacted, diagnostic and treatment facilities are being widely extended, and altogether the prospects are bright that these ancient scourges will soon be definitely controlled.

SYPHILIS OR LUES

The early history of syphilis is still shrouded in darkness. The earliest definite records of the disease date from 1495 in upper Italy and Germany, a fact which much later gave rise to the legend that the infection had been brought to Europe from America by some of Columbus' sailors. Diligent historical investigators, however, indicate that syphilis was prevalent in France many years prior to this time and that French physicians were quite familiar with the infection. The statement is often made that on its first appearance in Europe syphilis ran an acute, febrile course and took on an epidemic character. But it must be borne in mind that at that time syphilis (great pox) was not distinguished from smallpox, so that it is probable that the febrile epidemic cases were smallpox. Almost coincident with the interest attracted by syphilis in 1495, we find the introduction of mercury ointment as a

means of treating skin eruptions, and this led to the recognition of great pox as a disease distinct from smallpox.

Nature of the Disease.—Syphilis is an infectious disease which occurs naturally only in man. It runs a chronic course with local and general manifestations. The infection always begins with a characteristic sore known as the "chancre" which develops at the site where the virus entered, usually about three weeks after the receipt of the infection. This constitutes the *primary* stage. Some weeks later there is a

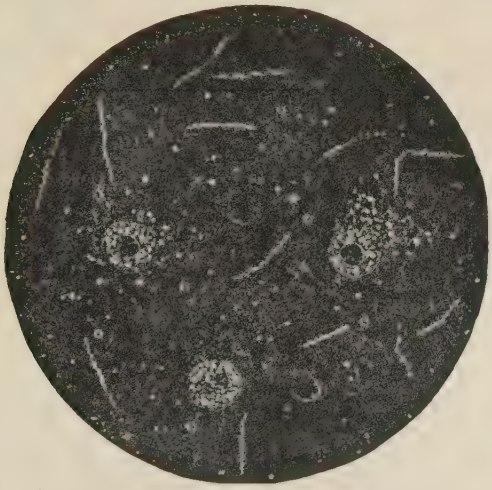


Fig. 55.—Treponema pallidum appearing as bright refractive corkscrews on a dark field, as shown by the dark-field microscope. (After Park and Williams.)

general invasion of the system by the causative microorganism, as shown by a general involvement of the lymph nodes, and eruptions upon the skin and mucous membranes. This is spoken of as the *secondary* stage. The lesions of both the primary and secondary stages are highly infectious and constitute the chief source of transmission of the disease to others. Years later, in the so-called *tertiary* stage, still other manifestations of the infection may appear in the central nervous system as locomotor ataxia (tabes) and paresis (general paralysis of the insane), in the heart and blood vessels

(*e. g.*, aneurysm), in the skin as ulcers and chronic syphilides, or as tumor-like growths (gumma) in various tissues of the body.

Cause and Transmission.—Syphilis is caused by infection with a very thin, pale, corkscrew-shaped micro-organism formerly classed among the protozoa, but now generally regarded as a spiral bacterium, the *Treponema pallidum,* formerly called "Spirochaeta pallida," discovered by Schaudinn and Hoffmann in 1905. By means of a microscope fitted with a device for dark-field illumination, the micro-organism can

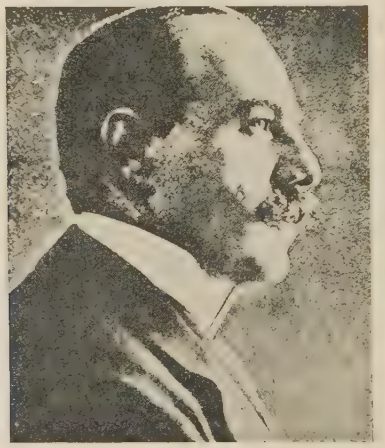


Fig. 56.—August von Wassermann (1866–1925).

easily be demonstrated in scrapings from the chancre and in the lesions of the secondary stage. The infection is transmissible by direct contact, most commonly through sexual intercourse, but also through kissing and in infants through suckling a breast having a fissure or sore infected with syphilis. Transmission may also be indirect, through infected articles such as cups and spoons. Finally, it must be remembered that syphilis can be transmitted from an infected mother to her offspring, this *congenital* form of syphilis usually first showing itself in the infant as "snuffles." In a large proportion of cases in which a mother becomes infected,

pregnancy does not go to term, the fetus dying and a miscarriage being the result. For this reason a history of repeated miscarriages should always arouse the suspicion that a syphilitic infection is present.

Prevalence.—The student will look in vain for accurate figures on the prevalence of syphilis, either from morbidity or mortality statistics. In a large proportion of cases, even though the physician knows that his patient died of syphilitic disease, consideration for the patient's family leads him to omit mention of this infection from the death certificate. In almost all large cities routine blood examinations by means of the Wassermann test on various groups in the population show that from 2 to 3 per cent of all adult individuals give evidence of syphilitic infection. Inasmuch as syphilitic infection is relatively infrequent in children under fifteen years of age, and since this age group makes up about one-fifth of the population in the United States, the prevalence of syphilis in the entire white population is probably between 1 and 2 per cent. Among Negroes the incidence is distinctly higher.

It is clear that a disease so commonly spread through sexual intercourse will be extremely prevalent among prostitutes. In these the incidence of syphilitic infection is ten to twenty times greater than it is in the rest of the population. For this reason the problem of controlling syphilis (and at the same time gonorrhea) is intimately associated with the very difficult question of prostitution. Fortunately we understand enough about the nature of syphilis, its mode of transmission, and treatment to know that much can be accomplished along purely medical lines without being compelled to take up the problem of prostitution as such.

Control Measures.—It is important that the student have clearly in mind the various stages of this disease. During the primary and secondary stage, syphilis is highly transmissible, and, although the infected individual suffers but little discomfort, he is a definite public health menace, and as such should come under the strict control of the health authority. This, in fact, is the principal reason for requiring the reporting of cases of syphilis to the health authorities. If the patient is under the care of a private physician, the health depart-

ment must have assurances that treatment is being carried out to render the infection noncommunicable. If the patient leaves the physician while the disease is still in the communicable stage, it is the duty of the physician to notify the health department of this fact, so that by means of a personal visit by a department representative, the patient may be returned to treatment. Similarly in the case of patients attending clinics, prompt notification must be made to the health department, which then has the responsibility of seeing that such "lapsed cases" receive treatment, at least to render the infection noncommunicable.

Economic Aspect.—In the later stages of syphilis not only may the patient undergo suffering, but he may become incapacitated for work and a burden on his family or the community. The individuals suffering from tabes dorsalis (locomotor ataxia) and general paralysis (paresis) constitute a large part of the patients in state and municipal hospitals. Cardiovascular syphilis is estimated by competent authorities to cause from 5 to 10 per cent of the deaths registered in the United States as due to heart disease. Not only do most of the patients showing these various late manifestations of syphilis die before their normal expectancy, but in many cases there is a period of from two to five years of invalidism. Altogether, syphilis thus imposes an enormous economic burden on the community.

It is only fair to say that in a considerable proportion of cases, even with little or no treatment, the patients show no untoward manifestations after the secondary stage. There is, however, no way to predict what course the infection will take in any particular individual, and serious sequelae often strike like a bolt out of the blue sky. For this reason all infected persons should receive prompt and adequate antisyphilitic treatment.

One speaks of infections acquired sexually as *venereal syphilis* and of those acquired extragenitally as *syphilis of the innocent*. The latter are very common, especially in countries where the precepts of hygiene are but little observed and where the inhabitants live in poverty, ignorance and promiscuity. Under such circumstances syphilis attacks chiefly children. Writing in 1906 Metchnikoff stated that 70 per cent

of the cases of syphilis in *rural* Russia were due to extragenital infection.

Diagnosis.—The diagnosis of syphilis is greatly aided by an examination of the blood by means of the Wassermann test. It is not possible in a work such as this to go into details concerning the rationale of the reaction or the technic. Suffice it to say that a positive Wassermann reaction, especially if it is obtained on repeated specimens, almost invariably indicates the presence of a syphilitic infection. It does not, however, indicate that the individual is actively infectious. On

Fig. 57.—Paul Ehrlich (1854–1915). Pioneer in studies on immunity.

the other hand, a negative Wassermann does not necessarily mean absence of infection, though the *repeated* occurrence of negative tests is very strong evidence that such an infection is not present. Since the Wassermann reaction does not appear until some weeks after the development of the chancre, this test is of no service in diagnosing the character of the primary sore. However, the accurate diagnosis of a suspected primary sore can readily be made by a "dark-field" microscopic examination of a drop of serum squeezed from the sore.

Treatment.—So far as the treatment of syphilis is concerned, a remarkable advance in this direction was made

when Ehrlich introduced arsphenamine (salvarsan) in 1910. At the present time this treatment is usually supplemented by treatment with some form of mercury, or with bismuth. When intensive arsphenamine treatment is begun very early, before the treponemata have invaded the system at large, the further development of the disease can sometimes be entirely arrested. The infection is aborted.

The effective treatment of syphilis usually demands injections of some form of arsphenamine and of bismuth or mercury, over a period of twelve to eighteen months. During recent years Chargin* and others have achieved excellent results with an intensive treatment with various forms of arsphenamine administered intravenously *within a week.* This treatment, however, demands expert medical and nursing supervision in a first-class hospital.

Prevention.—Preventive measures against syphilis must concern themselves first of all with the early recognition and prompt and adequate treatment of all cases of infection. Early diagnosis of the primary sore is much facilitated by the microscopic examination with dark-field illumination of the serum expressed from the sore. Special clinics for the diagnosis and treatment of venereal diseases should be provided by health authorities. Attention should be paid to the harm done by advertising quacks and by self-medication with patent medicines. Franker discussion of venereal diseases as health problems should be encouraged, and young people should be educated in sex hygiene. The importance of early and persistent treatment by a competent physician should be stressed, the more frequent employment of routine Wassermann blood tests should be urged, and adequate facilities for treatment should be provided for those unable to afford the services of a private physician. Detention hospitals should be established for the care of prostitutes found infected. Syphilis should be made a notifiable disease, to the end that the health authorities may be able to place all infected individuals under suitable medical supervision.

In New York, as in a number of other states in the Union, applicants for a marriage license must submit to a physical

* Jour. Amer. Med. Assoc., March 16, 1935; Am. Jour. Syph., Gon. and Ven. Disease, November, 1939.

examination and to a blood test by the Wassermann or other acceptable technic. Moreover, with a view to reducing congenital syphilis, New York State also requires a blood test for syphilis on all pregnant women. Information regarding such test must be entered on the birth certificate.

GONORRHEA

Gonorrhea is much more prevalent than syphilis and, unfortunately, its seriousness is greatly underrated. This is largely due to the fact that the acute stage rarely confines the patient to bed and soon subsides, while the serious *sequelae* may not show themselves until much later. Among the common consequences we may mention: gonorrheal arthritis, prostatitis and stricture of the urethra in the male, and chronic endocervicitis and salpingitis in the female. Gynecologists find that a large part of their practice is made up of the sequelae of gonorrhea.

Sterility is a common and very serious sequel to gonorrhea. It may be caused, in the male, by an inflammation of the testicle, and in the female by a salpingitis, which closes or obstructs the fallopian tubes.

A large proportion of the cases of preventable blindness are due to gonorrheal ophthalmia.

Gonorrhea is caused by a gram-negative diplococcus, the "gonococcus," discovered by Neisser in 1879 and today known as *Neisseria gonorrhoeae.* This micro-organism is found in large numbers within and between the pus cells of the gonorrheal discharge. The disease is usually transmitted through sexual intercourse, but a large number of infections of the innocent are also met with, especially in the form of vulvovaginitis in infants.

From the standpoint of transmission it is the unrecognized case of gonorrhea that is the more important, the case that is believed to be cured. This is common among patients who have treated themselves with patent medicines.

Until recently the successful *treatment* of gonorrhea was extremely difficult. Since the introduction of chemotherapy, however, the picture has changed markedly. In a very large proportion of cases, especially when treated early in the

course of the disease, a prompt cure of the infection results. However, since an attack of gonorrheal infection produces almost no immunity, such cured patients can readily develop a fresh infection after renewed exposure. It is too early to say what effect the success of sulfanilamide treatment will have on the prevalence and ravages of gonorrhea.

Preventive measures must be directed principally toward educating the public to realize the seriousness of gonorrheal infection and the necessity for thorough cure. Much of what has been said in discussing syphilis is applicable to gonorrhea also, especially the danger of self-medication and quackery, and the importance of education.

CHANCROID (Soft Chancre)

Chancroid is a specific, local, highly infectious venereal ulcer caused by a streptobacillus first described by Ducrey in 1889 and known as *Hemophilus ducreyi.* The ulcers are often multiple and, like "fever blisters," may inoculate themselves on other parts of the body. Chancroid may lead to severe complications, especially to various forms of phimosis, cellulitis and inguinal adenitis (buboes). The disease is usually contracted through sexual intercourse. A little soap and water at the time of exposure is an almost absolute preventive. After the ulcer has once developed, chemotherapy with the sulfonamides usually brings about prompt healing.

LYMPHOGRANULOMA INGUINALE (Lymphopathia Venereum)

Lymphogranuloma inguinale, a disease recognized in the tropics for over a hundred years, has repeatedly been encountered in recent years also in temperate countries. The disease is contagious and is usually spread through sexual intercourse. It begins as a small herpes-like sore or ulcer on the external genitalia and from there is carried to the inguinal lymph nodes which become swollen and may break down to form pus. The infection is caused by a filtrable virus.

CHAPTER XVIII

MALARIA, YELLOW FEVER AND AFRICAN SLEEPING SICKNESS

THE diseases mentioned in the title of this chapter are discussed together for several reasons: (1) each of them is a major scourge of tropical countries; (2) in each disease the causative agent is transmitted to man by an intermediate insect host; (3) in each, this agent is present in the blood. In malaria and yellow fever the hosts are mosquitoes; in African sleeping sickness, a species of fly.

MALARIA

As implied by the name, malaria (bad air) was formerly thought to be due to air which had in some way become poisoned, especially by the emanations from swamps and other damp places. The disease was well known to the Ancients and was perhaps introduced by slaves from Africa. The statement has been made that the decay of Greek civilization was largely due to the great increase in the prevalence of malaria. Certain parts of Europe were known to be hotbeds of malaria during the Dark Ages; among these the Roman campagna and the marshes of the Danube were in particularly evil repute. The disease is found in almost all parts of the world in the temperate and torrid zones. The Spaniards found it when they came to South America and Mexico.

In 1880 Laveran, a French army surgeon, demonstrated the causative parasite in the blood of persons ill with malaria, and by experiments carried out in 1895–98 the English army surgeon Ronald Ross showed that the parasite was transmitted by the bite of an infected mosquito. From this time on numerous other workers contributed much to our knowledge of malaria, so that at present there is hardly another infectious disease whose nature, occurrence, mode of trans-

mission, and methods of control are so well understood. Naturally we know now why the disease was so long regarded as being in some way connected with marshes and dampness; for stagnant water is essential to the propagation of mosquitoes, and without mosquitoes there can be no transmission of malaria. Not every mosquito is capable of transmitting malaria. In fact, the disease is traceable to but one kind of mosquito, namely, the genus *Anopheles*.

Malarial Parasites.—The parasites of malaria, *Plasmodium vivax, P. malariae* and *P. falciparum,* are called "hemamebae"

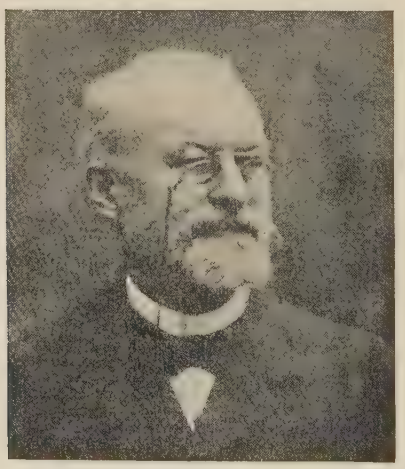


Fig. 58.—Alphonse Laveran (1845–1922).

because they invade the red blood cells. It has been found that the hemamebae have two distinct life cycles, one in man, the other in the mosquito. Let us begin with the description of the latter.

When the anopheles bites a person having malaria, and thus sucks into its body some blood which contains malaria parasites, the latter conjugate in the stomach wall of the mosquito; that is to say, the female malaria parasites are fertilized by the males in the stomach of the mosquito. The resulting young develop, until at the end of ten to fourteen days they are liberated into the abdominal cavity of the

mosquito. From this they pass to the salivary glands and then, through the bite of the insect, into the next human host. The changes which the malaria parasite undergoes in the mosquito's body require about twelve days. The mosquito cannot, therefore, transmit malaria to another person until this time has elapsed. However, once these changes have taken place, the mosquito can infect many persons in succession. The malaria parasite seems to be harmless for the mosquito itself.

Fig. 59.—Ronald Ross (1857–1932).

When introduced into man by the bite of an infected mosquito, the parasites enter the blood stream and penetrate into the red blood cells. After having invaded a blood cell, the parasite undergoes a characteristic cycle of development; it grows larger and somewhat rosette shaped, so that near the end of the cycle the rosette is seen to consist of eight to ten young parasites, each like the one originally lodged in the red blood corpuscle. The blood cell, meantime, has been completely destroyed, and now the young parasites are set free in the blood stream where each at once lays hold of another red blood cell. This keeps on indefinitely, the com-

plete cycle from blood cell to blood cell taking forty-eight hours in the case of the hemameba of *tertian* malaria (so called because chills and fever occur every other day) and seventy-two hours in the hemameba of the *quartan* type (chills and fever every fourth day).

There is still a third variety of hemameba, the *estivo-autumnal* parasite, which is the cause of a highly dangerous form of malaria prevailing in the tropics.

Treatment.—In 1638 the Countess of Chinchon, wife of the Viceroy of Peru, was cured of malaria by the use of Peruvian bark, which had been sent to her by the corregidor of Loxa, who had learned of its use from the natives of Peru and had employed it successfully on himself. Subsequently this Peruvian or Chinchona (Cinchona) bark was introduced into Europe by the Jesuits (therefore also called "Jesuit bark") for the treatment of malaria, and soon became famous as a specific remedy of the disease. In the treatment of malaria Peruvian bark has been superseded by quinine, its chief active constituent.

Control of Malaria.—From what has been said, it is clear that the control of malaria can be undertaken from several different angles.

Since quinine kills the parasites in the human host, one can, by the administration of quinine to all infected individuals, so reduce the sources from which mosquitoes can become infected that malaria-infected mosquitoes are a rarity.

In addition to this, one can, by the routine administration of quinine to *all* persons living in malaria-infested districts, prevent the development, in persons bitten by infected mosquitoes, of sufficient malaria parasites to produce symptoms or to render such persons sources of infection for other mosquitoes.

By the careful screening of doors and windows and by keeping indoors in the evening, one can guard against the bites of infected mosquitoes.

By draining ponds and marshes much can be done to prevent the breeding of malaria-carrying mosquitoes. Often good results are obtained by clearing the shores of vegetation and stocking the ponds with minnows, which feed on mosquito larvae.

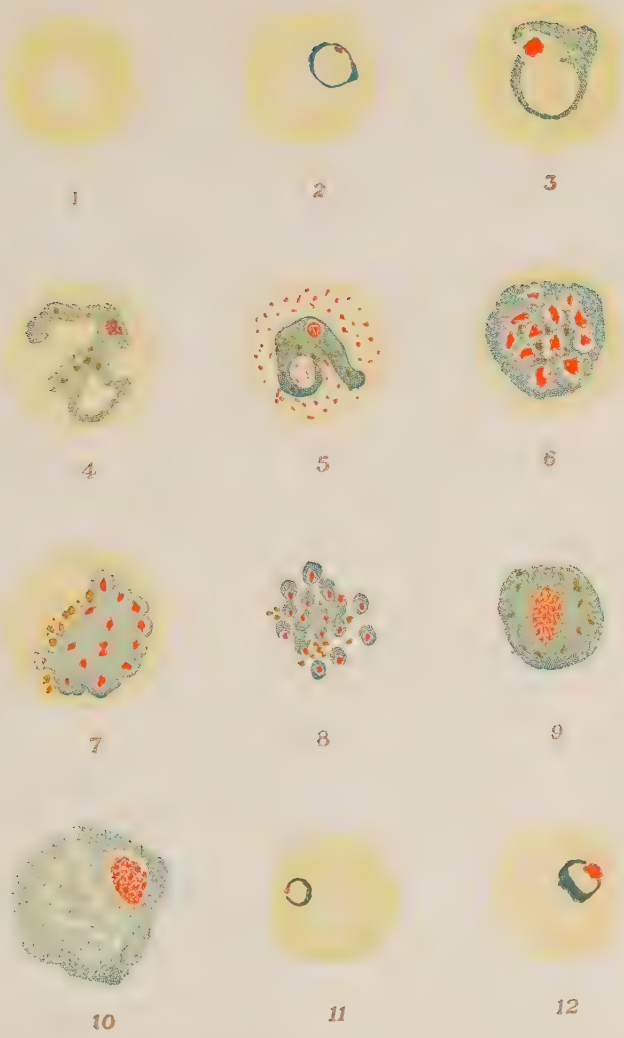


Fig. 60.—Malarial parasites: 1 to 10 inclusive, tertian parasites; 11 and 12, quartan parasites. 1, Normal red blood cell. 2, Young tertian ring. 3, Large tertian ring. 4, Half-grown tertian parasite. 5, Infected cell showing Schüffner's dots. 6, Adult tertian parasite. 7, Beginning sporulation. 8, Sporulation completed. 9, Tertian microgametocyte. 10, Tertian macrogamete. 11, Young quartan ring. 12, Older quartan ring. (Deaderick, Study of Malaria.)

Where neither of these methods of dealing with ponds and other stagnant waters is possible, one can spray the waters with crude petroleum or other larvicide in order to kill the aquatic forms of the mosquito.

Finally, conditions may be such that ponds and marsh lands may be filled in, thus depriving the mosquitoes of their natural breeding places.

In practice one must usually employ all of these methods in combination, at least as far as local conditions permit. Many of the methods entail enormous expense, and though they may be highly desirable, will not be feasible for financial reasons.

YELLOW FEVER

Yellow fever was formerly regarded as the classic example of a disease spread by fomites. Always a great scourge in the tropics, the disease repeatedly raged in epidemic form in the Southern States and even as far north as New York. It is a serious infection, the mortality raging from 25 to 75 per cent or more.

Our knowledge of the manner in which yellow fever is transmitted dates from the brilliant work of a commission of United States Army officers, composed of Reed, Carroll, Lazear and Agramonte.* As a result of their investigations carried on in Cuba in 1900 to 1902 we now know that yellow fever is transmitted in nature by the bite of infected mosquitoes known as *Aëdes egypti* (originally called "Stegomyia fasciata"). These observers also showed that such mosquitoes become infected by biting an infected person, and that an interval of twelve days must elapse before the mosquito so infected is capable of conveying the infection to another person.

It is only fair to say that Dr. Carlos Finlay, of Havana,

* In order to prove the correctness of the conclusions of this commission, Lazear allowed himself to be bitten by a mosquito which previously had been made to bite a patient ill with the disease. After the usual period of incubation he developed a severe attack of yellow fever and died, a martyr to medical science.

Subsequently the deaths of Stokes, Noguchi and Young of yellow fever in Africa added three more illustrious names to those who sacrificed their lives to this disease in the cause of humanity.

had previously insisted that yellow fever was spread by mosquitoes and he had also called attention to the interval between the primary and secondary cases. His published observations, however, were disregarded.

Yellow fever is an acute infectious disease, characterized by a sudden onset and prostration, with fever, marked albuminuria, petechial hemorrhages of the mucosa of the alimentary tract, with a consequent vomiting of altered blood ("black vomit"), and jaundice.

Although various germs were, at different times, regarded as the causative agent of yellow fever, the work of Stokes and

Fig. 61.—Major Walter Reed.

his associates showed that none of these could be accepted, but that in fact the *causative agent* is a filtrable virus of relatively small size. When dried, the virus will remain viable for years. It can be grown in tissue culture. It is present in the blood of patients, but only during the first three or four days of the disease, which interval is therefore the only one during which the disease can be transmitted by the bite of the mosquito.

Infection with the virus and subsequent recovery gives a permanent immunity to man and experimental animals. The immunity manifests itself by the appearance in the animal's serum of a virus-neutralizing antibody.

By testing the blood of large numbers of persons for yellow fever antibody, we have learned about the *geographical distribution* of yellow fever. Of special concern to the United States is the recent discovery that large areas of Brazil, in which the *Aëdes egypti* mosquito is not found, harbor the infection. With the extensive and growing airplane service between Brazil and the United States, this will necessitate careful control measures to prevent the introduction of yellow fever into this country.

The *control* of yellow fever lies in (1) the effective screening of all patients, so that mosquitoes cannot bite them and

Fig. 62.—General William C. Gorgas (1854–1920), pioneer in the application of modern methods in tropical sanitation.

carry the infection to others; (2) extermination of the species of mosquitoes known to transmit yellow fever; and (3) the use of vaccines for making persons immune to infection. Vaccines made from yellow fever virus are now available and have proved effective.

AFRICAN SLEEPING SICKNESS (Trypanosomiasis)

African sleeping sickness is an infectious, febrile disease limited to tropical Africa. It is caused by a protozoon, the *Trypanosoma gambiense*, and is transmitted by the tsetse fly, *Glossina palpalis*. The intermediate host of the parasite is not definitely known, but is suspected to be the hippopotamus.

The disease begins with an irregular fever, glandular enlargement, a rash, and localized edemas. Later the trypanosomes invade the cerebrospinal fluid, giving rise to a slowly increasing lethargy and other morbid, nervous symptoms. Few patients recover. *Preventive measures* consist in isolating the patient and protecting both the sick and the well against the bite of tsetse flies. It is especially important to isolate all who harbor trypanosomes in their blood, whether they feel sick or not. As a rule it is almost a hopeless task to eradicate the tsetse flies, though around ports, in the neighborhood of villages, wharves and other places this should be attempted.

African sleeping sickness must not be confused with the so-called "sleeping sickness" which occurs in Europe and in this country. The latter, *encephalitis lethargica,* or epidemic encephalitis, is caused by a filtrable virus, and is in no way related to the trypanosome infection of Africa (see page 167).

CHAPTER XIX

IMPORTANT INFECTIOUS DISEASES OF THE CENTRAL NERVOUS SYSTEM

CEREBROSPINAL MENINGITIS

Cerebrospinal meningitis is an acute, communicable, febrile infection of the lining membranes of the brain and spinal cord, often occurring in epidemic form and frequently ending in death. The *causative agent* is a gram-negative diplococcus found in the leukocytes of the spinal fluid. This micro-organism was discovered in 1887 by Weichselbaum, who gave it the name "Diplococcus intracellularis," though now it is usually called *Neisseria intracellularis,* or the "meningococcus."

The meningococcus probably enters the body through the nose from where it may pass directly to the brain. Moreover, it may be found in the nasal secretion of many persons ill with cerebrospinal meningitis and also in a considerable number of persons in contact with such patient. It is these "carriers" who probably play an important part in the spread of the disease, and who account for most of the sporadic cases.

Meningitis may also be caused by other micro-organisms, such as the tubercle bacillus, the pneumococcus and the influenza bacillus, but none of these give rise to a meningitis which occurs in epidemic form. The epidemic variety is always caused by the meningococcus of Weichselbaum.

The first epidemic outbreak of meningitis was reported in Geneva, Switzerland, in 1805. Since that time frequent epidemics have occurred, both here and abroad. The one of 1904 to 1905 in New York embraced 6755 cases, with 3455 deaths. Most of the epidemics occur in winter and spring, subsiding with the onset of warm weather. There appears to be a definite cycle in the recurrence of epidemic outbreaks. This is well presented in the graph showing the occurrence of epidemic meningitis in New York City.

Diagnosis of cerebrospinal meningitis should be by the bacteriologic examination of the spinal fluid obtained through lumbar puncture. The fluid is usually increased in amount,

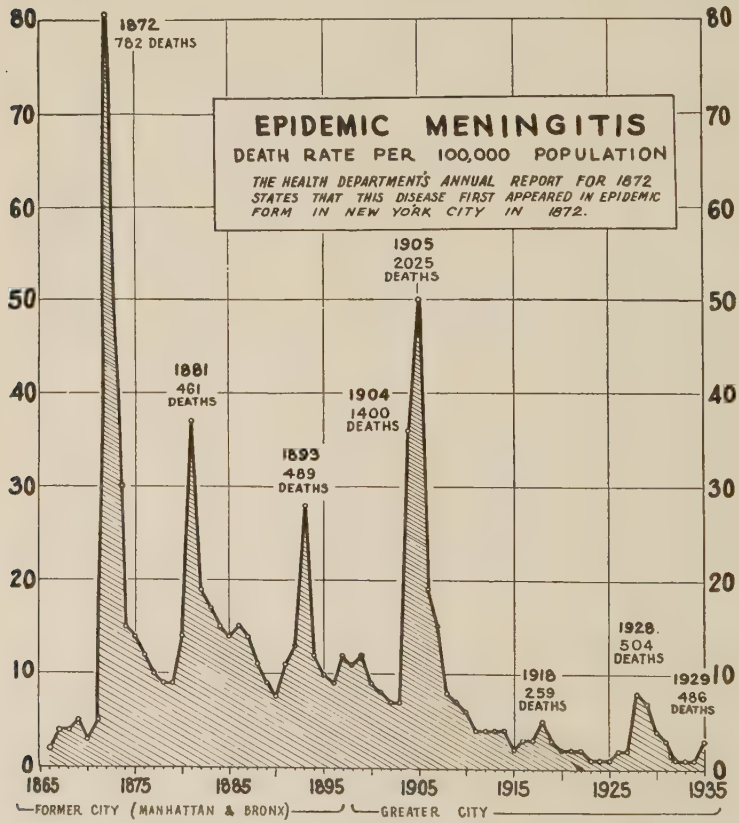


Fig. 63.—The death rate of epidemic meningitis per 100,000 of population in New York City. The case incidence is not charted because of inaccurate figures especially in the earlier years. The effect of serum treatment, started about 1907, is suggested by a lower death rate since that date.

is under increased pressure, is cloudy in appearance, and when examined microscopically, stained according to Gram's method, shows gram-negative diplococci within the pus cells.

Until recently the only therapeutic agent available for the *treatment* of epidemic meningitis was the specific antimeningococcus serum first prepared by Jochmann in Germany. The serum is administered intraspinally, and if used early reduced the mortality to about half that in untreated patients. Recent medical literature brings an increasing number of reports of striking results from treatment with sulfanilamide.

So far as *preventive measures* are concerned, the patient should be isolated and every precaution taken to prevent infected discharges spreading the disease to others.

POLIOMYELITIS (Infantile Paralysis)

Poliomyelitis is an acute infectious and communicable disease, characterized by paralysis of various groups of muscles, due to the invasion of the motor nerve cells of the brain and spinal cord. It often occurs in epidemic form. The *causative agent* of the disease is a filtrable virus, which, after having gained access to the body, lodges in the gray matter in the anterior portion of the spinal cord, where it injures or destroys the nerve cells. Inasmuch as these nerve cells give rise to the motor nerves, varying degrees of paralysis result. If the nerve cell is only injured, it may, after a time, recover. A nerve cell which is destroyed cannot, however, be replaced.

The virus has been demonstrated in washings of the nasopharynx of patients as well as of carriers, and appears to enter the body through the nose, traveling thence through the substance of the olfactory nerve, through the brain, and into the spinal cord. Very recently the virus has also been demonstrated in the intestinal excretions and in sewage, and it may be that this will modify our views regarding the epidemiology of the disease.

The disease is much more common among children than among older persons, though the latter are occasionally attacked. For reasons not at all understood, poliomyelitis frequently takes on epidemic form. In New York City such epidemic outbreaks occurred in 1907 (approximately 2500 cases), 1916 (over 9000 cases reported), 1931 (over 4100 cases reported) and 1935 (over 2100 cases reported). It will be

observed that there is no constant interval between these epidemic outbreaks.

The virulence of the disease in these outbreaks has varied considerably. In 1907 the case fatality, as far as it could be estimated was not over 5 per cent; in 1916 it was over 27 per cent; in 1931 it declined to 12 per cent and in the 1935 outbreak it was less than 5 per cent.

Fig. 64.—The oldest known illustration of infantile paralysis. From an Egyptian stele now between 3000 and 4000 years old. (From The Peaks of Medical History, by Charles L. Dana. Paul B. Hoeber, Inc., Publisher.)

In New York City, since 1907, the disease appears to be shifting to higher age groups. Thus in 1907 over 86 per cent of the cases occurred in children under five years of age; in 1916 80 per cent were in this age group; in 1931 only 52 per cent and in 1935 only 33 per cent. The reason for this shift in the age affected is not understood.

How the disease is transmitted from person to person is

not at all clear. Accepting virus-laden nose and throat discharges as the most likely means of transmission, epidemiologists could not explain the fact that poliomyelitis is usually a disease of hot weather and quickly subsides in the fall. In contrast to this, almost all the diseases generally regarded as spread by infected nose and throat discharges (diphtheria, scarlet fever, measles, whooping cough, common colds, influenza) are most prevalent during cold weather. For this reason some insect carrier was thought to be the transmitter of the infection, just as mosquitoes transmit malaria, yellow fever and dengue. Searching entomological studies, however, have failed to give any clue to any insect carrier. The presence of the virus in the intestinal excreta suggests that the infection might be spread through swimming pools. But this possibility has repeatedly been explored by epidemiologists with negative results. For the present we must admit complete ignorance as to the manner in which the disease is spread. We must, of course, bear in mind the presence of the virus in the nose and throat of patients and of some of the contacts, and the recent observations regarding its presence also in the feces. The patient should be isolated during the acute stage, he should be screened against flies and mosquitoes, and there should be the usual precautions against spread of the infection by proper attention to the discharges of the nose and throat and of the intestines.

Some years ago we were encouraged by announcements of a successful vaccine for protecting children against poliomyelitis. Extensive trials showed that they were worthless, and some were even dangerous.

ACUTE INFECTIOUS ENCEPHALITIS

Thus far we have discussed an epidemic disease affecting the lining membranes of the brain and spinal cord (epidemic cerebrospinal meningitis), and another which has a selective action on the motor nerve cells of the brain and cord (poliomyelitis). We shall now consider an acute infectious disease, often occurring in circumscribed outbreaks, which affects the entire substance of the central nervous system, namely acute infectious encephalitis.

Depending on the site and nature of the pathological changes, acute infectious encephalitis gives rise to a large variety of symptoms in different cases. Mental deterioration is a common sequel. Death is not uncommon. A large proportion of the patients recover rapidly after the acute illness; others remain more or less invalid for months or years and then recover, but many patients are permanently disabled because of the residuals or sequels of the disease.

Attention was first attracted to infectious encephalitis by the work of von Economo who, during the World War, described outbreaks of an inflammation of the brain which he called "encephalitis lethargica"* because of the lethargy which was so frequent and marked a symptom. Subsequently, from various parts of the world, other outbreaks of acute encephalitis were reported, though with somewhat different clinical symptoms and often with few cases showing the lethargy described by von Economo. Thus there was an extensive epidemic in St. Louis in 1933 and also outbreaks in Japan and elsewhere.

Acute infectious encephalitis is caused by a filtrable virus, but the viruses encountered in different outbreaks differ from one another. How the infection is spread has not been determined. Attempts to discover an insect vector have failed.

In recent years there have been reported outbreaks of a disease known as *equine encephalomyelitis* among horses and mules in different parts of the United States and elsewhere. In connection with these epizootics,† human infections have also been observed. The disease is caused by a filtrable virus, which, however, differs somewhat from the human encephalitis virus isolated in St. Louis and in Japan. Human infections appear to have been transmitted from the horses and mules by mosquitoes and perhaps by flies and other insects. The infection occurs also in pigeons and other birds. In fact, it is believed that this is the natural reservoir for the virus, and

* In newspaper accounts, this term was unfortunately popularized into "sleeping sickness," thus confusing it with the dreaded African disease caused by infection with trypanosomes. For a discussion of the latter see page 162.

† *Epizootic,* a disease affecting a group of animals; analogous to *epidemic,* a disease affecting a group of people.

that only when the disease in these animals rises above a certain epizootic level, does it spread to horses and man.

LYMPHOCYTIC CHORIOMENINGITIS

In 1925, Wallgren called attention to cases of meningitis in which the usual bacteriologic cultures made at autopsy remained sterile. He insisted it was a distinct disease and called it "aseptic meningitis." It is now known that a filtrable virus is responsible, and because the spinal fluid in these cases contains predominantly or entirely lymphocytes, the condition is spoken of as "lymphocytic choriomeningitis." The causative virus, first isolated by Armstrong of the U. S. Public Health Service in 1934, has since been recovered in several localities in the United States, England, France and Japan. Evidence indicates that mice may play a part in the transmission of the disease.

RABIES (Hydrophobia)

Rabies is an acute, infectious, and highly fatal disease of the lower animals, occasionally transmitted to man through the bites of infected animals, especially rabid dogs.

Rabies has become disgracefully prevalent in the United States. Thus in New York City, for which recent figures are available, the number of animals found to be rabid is given in the table on page 170.

In 1940, in New York City, 127 persons were bitten by *animals known to have been rabid.* Conditions are similar in almost all parts of the country, and energetic action is needed to eradicate this wholly preventable disease. England has had practically no rabies for years; neither has Holland nor Sweden.

The essential *cause* of rabies is a filtrable virus which is present in the saliva of rabid animals and in the cells of the central nervous system of such animals. In these cells the virus causes the formation of cytoplasmic inclusions known as *Negri bodies,* after the Italian scientist who first described them in 1903.

Rabies is *spread* principally by the homeless, stray dog. With its large cruising radius, an infected stray dog can bite

and infect a large number of other dogs in a short time. Such a case came to the writer's notice recently. One rabid dog bit and infected other dogs, these, in turn, bit and infected a second group, and some of these even a third. Altogether 34 cases of rabies in dogs developed.

The following table shows the number of rabid animals in New York City as disclosed by laboratory examinations:

Laboratory Examination of Brains of Suspected Animals

Year.	Number examined.	Rabid.
1931	486	56
1932	413	18
1933	458	26
1934	574	44
1935	475	20
1936	460	27
1937	485	68
1938	549	89
1939	526	58
1940	598	117

When a person has been bitten by a dog suspected to be rabid one should, of course, first *treat the wound.* This is done by cauterizing it thoroughly with fuming nitric acid and then applying a clean dressing. The next step will depend on whether or not the animal was really rabid. If the dog is still alive it is advisable not to kill it, but to fasten it securely by a chain in a kennel or inclosure where no other animal or person can have access to it. *If the dog has rabies,* paralysis will develop and the animal will die, usually within four to five days. If no paralysis develops and the dog is alive at the end of two weeks the disease is not rabies, and the animal may be released with safety. If the dog has been killed, it is important to establish a correct diagnosis by microscopic examination of the dog's brain for the presence of Negri bodies. To do this satisfactorily the brain must be quite fresh. In warm weather, therefore, either the entire carcass or at least the dog's head must be packed in ice and sent at once to the laboratory for examination. At the laboratory, smear preparations are made from certain parts of the brain, stained and examined for Negri bodies. When these are found, a positive diagnosis of rabies is established.

All persons bitten by a rabid animal should submit to a course of Pasteur treatment (or one of its modifications). Essentially this consists in spaced injections of attenuated or killed rabic virus, given for the purpose of bringing about an immunity to rabies. As a result of recent improvements in this preventive treatment (Semple's killed virus) one can now keep on hand a supply of the Semple virus for prompt administration to those bitten by rabid animals.

The *prevention* of rabies resolves itself principally into an effective control of dog bites through the strict enforcement of muzzling or leashing ordinances and the collection and destruction of stray dogs. Wherever this policy has been rigorously carried out, rabies has been eradicated.

A single injection method of rabies "immunization" of dogs has been widely propagandized for the protection of pet dogs. The best authorities condemn the method.

CHAPTER XX

FOOD POISONING

Acute illness associated with the ingestion of contaminated food or drink is very frequent, in fact far more so than is generally believed, for usually it is only when a larger number of such cases occur together, or when some peculiar circumstance draws attention to a common factor that the matter attracts attention and comes to the notice of the health authorities.

There is little doubt that many isolated cases of food poisoning are not recognized as such, the condition often being dismissed as an "upset stomach" and ascribed to some error in diet. It is estimated that at least 15,000 to 20,000 cases of food poisoning occur annually in the United States, the great majority in the summer. In New York City several hundred outbreaks, involving a total of over 1000 persons, are reported annually.

Cases of food poisoning can be divided into three broad groups; those due to accidental contamination of the food with a poisonous substance, those due to eating poisonous plants or animals mistaken for edible food, and those due to contamination of the food by certain varieties of bacteria. The last group is by far the most common. The others can be dismissed in a few words.

ACCIDENTAL CONTAMINATION WITH POISONOUS SUBSTANCES

Cases of food poisoning due to accidental contamination with poisonous substances are now and then encountered, but on the whole they are infrequent. In some of the reported cases a white powder in an unlabeled bag of insecticide has been used by a housewife instead of flour. In other cases poisoning has resulted from the residue of arsenic insecticide sprays on fruits and vegetables eaten raw. The latter form

of poisoning manifests itself slowly, occasionally with jaundice as a symptom, and is not readily recognized. With the extensive use of arsenic as an insecticide spray, cases of mild poisoning from this source may be more frequent than the reported instances indicate. Thus far, however, survey examinations of fruits and vegetables fail to support this view. The authors take this opportunity to condemn the statements made regarding the alleged "serious danger of the use of aluminum cooking utensils." Wholly unsupported and widely propagandized statements have been made that the use of such cooking utensils leads to cancer and other human ailments. There is not a particle of evidence that this is true. Cases of lead poisoning have now and then been encountered through the use of lead pipes in the manufacture and dispensing of beverages, but nowadays such cases are very rare.

POISONOUS PLANTS AND ANIMALS MISTAKEN FOR EDIBLE FOODS

In the United States cases of food poisoning due to the eating of poisonous plants mistaken for edible foods occur occasionally among immigrants but are uncommon among native Americans, and most of those which do occur are due to poisonous fungi closely resembling edible varieties found in European countries. In the latter countries poisoning is also occasionally encountered due to mistaking so-called "Toll Kirschen" (belladonna) for edible fruit. Such cases are extremely rare in this country. Now and then children are poisoned by swallowing the beans of the castor oil plant, which contain a virulent poison called ricin.

In recent years, in California, in Japan and along the northern Atlantic Seaboard (Nova Scotia), cases of poisoning have resulted from the eating of mussels. Careful study has shown that at certain times of the year and under special circumstances, the ordinary edible mussels may become poisonous, so much so, that fatal human cases have been reported. The condition is caused by a poisonous plankton on which the mussels have fed. Arctic explorers report that the Eskimos, who eat almost all varieties of animals, including

the entrails, will not eat the liver of the polar bear, which is poisonous. Numerous experiences attest this fact. Even the dogs when starving will leave such liver untouched. Altogether this group of food poisonings constitutes only a very minor health problem.

BACTERIAL FOOD POISONING

Food poisoning as a public health problem is largely confined to cases in which the ingested food has been contaminated by certain varieties of bacteria or by their products. We speak of these as bacterial food poisoning. Because they were found to be associated especially with meat and other protein foods, these cases were long described as "ptomaine poisoning," and were thought to be due to poisonous decomposition products of the protein called "ptomaines." It is now well known that such decomposition is not in itself the important element, but rather that symptoms of illness follow either the introduction of specific pathogenic bacteria themselves (food infections) or the introduction of specific toxic substances produced by the bacteria (food intoxication).

The Food Infections.—In these, the bacteriological findings are of primary importance. It is now well established that the great majority of cases of this type are due to organisms of the Salmonella family, formerly included in the general paratyphoid B group. Three main types of such organisms are described, *Salmonella typhi murium, S. suipestifer,* and *S. enteritidis.* Although there are upwards of 75 different *Salmonellae* at present recognized by bacteriologists, three quarters of all food poisoning cases are considered by some authorities to be due to one of these three types. In general the food which causes food poisoning infections is of protein nature, often meat previously chopped, and allowed to stand for some time with inadequate refrigeration. Very often the offending organisms can be recovered from left-over products, if these are available, and in the intestinal discharges of patients. In a few instances bacteria normally present in the intestine and other mildly pathogenic organisms may cause outbreaks. For example, atypical Escherichia coli, Bacillus proteus and dysentery bacilli have been described as occurring in foods involved in food poisoning outbreaks.

These organisms gain entrance into food in several ways For example, they may represent primary unrecognized infections of the animals whose meat is being used for food; other sources are contamination of wholesome meat by bacteria from a mild human case of food infection or the carrier state in a foodhandler, or from contamination of food by mouse or rat excreta in the places where food is prepared. These rodents are frequently carriers of *Salmonella typhi murium,* which causes in them a disease resembling typhoid fever. Once these organisms are seeded in a food in sufficient numbers they grow rapidly and continue their growth after ingestion. Following an incubation period varying from six hours to three days, symptoms such as nausea, vomiting, abdominal pain, diarrhea and fever occur. Recovery from these symptoms in most cases is prompt within one or two days, although at times a period of pronounced exhaustion may intervene. It is important to note that in these infections the food responsible may not differ in any way in appearance, smell or taste from normal.

The Food Intoxications.—In the food intoxications the organisms responsible have had sufficient time and a favorable enough medium in which to grow and produce their individual exogenous toxins. Subsequent ingestion of the food containing these very potent toxins gives rise to symptoms without any further growth of the organisms in the human intestinal tract. By far the largest proportion of such food intoxications are caused by two germs, the Clostridium botulinum, producing the condition called "botulism," and the staphylococcus.

The poison of the Clostridium botulinum is so powerful that a fatal dose may be as low as 1/100 of a milligram. From the beginning of this century to 1925, there were reported in the United States 150 outbreaks of botulism with over 500 persons involved, two thirds dying. During this period many outbreaks were traced to home canned foods, particularly vegetables. These had become contaminated with *Clostridium botulinum,* a normal inhabitant of many soils, and because of improper canning, there had resulted a growth and the formation of the toxin. In contrast to the unchanged condition of the food in food infections, improperly canned

products infected by the organism of botulism frequently show some indication (appearance, odor or taste) of spoilage. In recent years outbreaks of the disease have become very infrequent, both because of the efficiency of commercial canning and the widespread educational campaigns directed toward proper methods of home canning.

The incubation period in botulism is short, usually less than twenty-four hours; it may, however, vary at times up to three days. Vomiting and constipation are often present, but the outstanding feature is paralysis of the cranial nerves. Loss of consciousness and subnormal temperature frequently occur; death follows in over 50 per cent of all cases.

The other large group of food intoxications is that caused by the toxins of the staphylococcus, both *Staphylococcus albus* and *S. aureus*. First noted in the early 1930's by Dack and Jordan and their co-workers, outbreaks due to these organisms are now recognized as being much more prevalent than was formerly realized. Growth of freshly isolated staphylococci, and in fact of streptococci, Bacillus proteus and many others, produces substances that cause gastro-intestinal irritation in monkeys used in feeding experiments. The work of Jordan and Burrows indicates that the production of such irritants is favored in a custard medium or one to which starch has been added. Foods such as these, especially those which have been prepared with insufficient heat or in which careful and continuous refrigeration of the finished product is not maintained, are often responsible for widespread outbreaks, particularly in the summer.

The incubation period in staphylococcic food intoxication is often short, in most instances one to four hours. Patients are rapidly prostrated with vomiting, diarrhea, abdominal pain and collapse. In almost all instances these alarming symptoms subside within one or two days and complete recovery takes place. Staphylococci, of course, are ubiquitous. They may enter the food from dirty hands or utensils, or from a boil or other skin infection in a foodhandler. Prevention of this type of food intoxication lies in complete sterilization of products in which organisms of this type may grow, and constant and adequate refrigeration after preparation of such products. Some health authorities have thought it

advisable to prohibit the sale of custard filled pastries in warm weather.

In order to guard against the various types of food poisoning, we must first of all rely upon government meat inspection supplemented by local administrative measures to prevent the slaughtering of known diseased cattle for food purposes. A second important consideration is absolute cleanliness in the handling and storage of food by individuals who are free from disease or carrier states. Food should be protected from insects, rats and mice, and adequately refrigerated at all times. *Finally, food which is at all suspicious as to appearance, odor or taste should be discarded. In home canning, short-cuts to do away with thorough prolonged heating should be avoided.*

CHAPTER XXI

HOOKWORM, TRICHINIASIS, FILARIASIS

HOOKWORM

Hookworm disease is an infestation with peculiar round worms, ½ to ¾ inch in length and about the thickness of a hairpin. The worms lodge in the intestine, fastening themselves to the mucous membrane, which they wound in order to suck blood. The loss of blood thus occasioned, together with a poison which the worm seems to produce, causes the infested individual to become very anemic and apathetic.

Hookworm disease is extremely prevalent in tropical and subtropical countries throughout the world and constitutes one of the greatest health problems in these regions. It numbers its victims by millions. Stiles, the first to call attention to the prevalence of hookworm in the United States, and the foremost authority on this disease, estimates the number of those infested with hookworm at 2,000,000 for the United States alone. The disease occurs among mine workers in temperate climates, causing what is known as "miner's anemia." Theoretically the prevention of hookworm disease is simple, for we know the parasite, its life history, and its mode of entrance into the body. We even have available a ready means of curing the disease. Practically, however, we have to deal with ignorance, apathy, poverty and uncleanliness—a combination of obstacles which is very difficult to overcome.

There are many different species of hookworm, and the parasites infest almost all mammalian animals. The two species which infest man, *Ankylostoma duodenale* and *Necator americanus,* are very similar to one another, they have the same life history, produce the same symptoms, are spread from man to man in the same manner, and respond to the same preventive and curative measures.

The adult female worm lays an enormous number of eggs, which pass from the human host in the feces. The eggs do not hatch except in the presence of oxygen, and thus the tiny embryo within the egg is not liberated until after the feces have been discharged to the outer world. Under favorable conditions the embryo escapes from the egg and becomes a larva, microscopic in size. This takes place in about twenty-four hours.

The young, freshly hatched larvae make their way from the feces on the ground into the moist soil, feeding on all the organic matter surrounding them. In the course of two days or more they shed their skin, *i. e.*, they moult. A week later the larvae moult again, but this time they become encysted

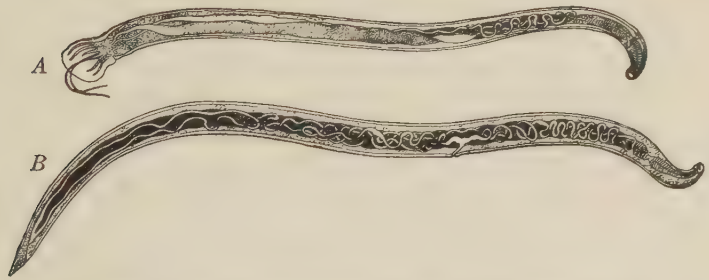


Fig. 65.—Necator americanus. *A*, Male; *B*, female (× 6).

within the old skins, and remain there in a resting stage for weeks or months.

This stage is especially interesting to sanitarians, for it is the one during which the larvae are transmitted to other persons, transmission taking place through the skin in a very curious manner. In tropical countries, where hookworm abounds, a large number of the poorer classes habitually walk barefooted. Moreover, in such regions there is usually an entire absence of sanitary privies, the natives depositing their excreta in any convenient spot, directly on the ground. Under these circumstances it is almost impossible for the natives not to soil their feet with earth containing some of the encysted larvae. When this occurs the larvae pierce the skin, usually in the softer regions between the toes, and find their

way through the subcutaneous tissue to the lymphatics. In their course the larvae irritate the skin, giving rise to what is known as "ground itch." The local symptoms may consist merely of a few itching papules or pustules, but may sometimes manifest themselves as a severe dermatitis.

From the site of penetration the larvae are carried by the lymphatics to the thoracic duct, *i. e.*, the vessel into which all the lymphatic system empties, which, in turn, pours them into the vena cava and so into the right side of the heart. From the heart the larvae pass with the blood stream into the lungs. Since the larvae are too large to pass through the capillaries in the lungs, they pierce the capillary wall and enter the air spaces of the lungs. In the course of their migration to this point the larvae have moulted three times in their human host. Mixed with mucus in the alveoli of the lungs the larvae pass next into the smaller bronchi, are coughed up, and then enter the stomach by being swallowed. From the stomach they pass into the small intestine, where they develop to maturity and repeat the elaborate cycle just described.

The *treatment* of persons infested with hookworm is simple, for the parasite is readily benumbed or killed by a number of drugs, such as thymol, oil of chenopodium, hexylresorcinol, tetrachlorethylene and other vermifuges. After a couple of treatments with one of these drugs, all or nearly all of the *adult* parasites are expelled in the feces. Usually two or three courses bring about a complete cure, though now and then more may be required. A microscopic examination of the feces for hookworm eggs will determine whether the treatment has been effective.

From what has been said regarding the life history of the parasite and the manner in which hookworm infestation occurs, it will be clear that our *preventive* efforts must embrace the following:

1. Discovery of all infested persons by means of microscopic examinations of feces for the presence of hookworm eggs.

2. Treatment of all infested persons to rid them of the parasites.

3. Provision of sanitary privies to prevent soil infestation.

4. Education of the people to make them realize the great danger of soil infestation through filthy, unsanitary practices with respect to the disposal of feces.

5. Discouragement of the practice of going around barefooted in regions where hookworm prevails.

6. Attention to water supplies in order to prevent the direct transmission of hookworm larvae through polluted drinking water.

Such a program entails the social and economic uplift of millions of people, and calls for an entire change in their daily hygienic habits. To carry it out will require the persistent, patient effort and cooperation of health authorities, educators, physicians, government agencies, and civic and philanthropic organizations.

TRICHINIASIS (TRICHINOSIS)

Trichiniasis is an infestation with a small worm, the *Trichinella spiralis,* due to the eating of raw or insufficiently cooked infested pork. In the flesh of the infested swine the parasite exists as a minute, spirally curled worm inclosed in an oval capsule about 0.015 inch long and 0.01 inch wide. When such infested meat is swallowed by man, this tiny worm develops in the intestine into the adult sexual worm which soon thereafter gives birth to a large number of larvae. The larvae leave the intestine by various ways and make their way into the victim's muscles, where they lodge, curled up within a small capsule or cyst. This causes the rheumatic-like muscular pains so characteristic of the disease.

Human infestation with trichinella is much more prevalent in the United States than the number of reported cases would indicate. On the basis of human autopsies, in which a careful search was made for trichinella, experienced investigators believe that the number of persons in the United States so infested runs into the millions. In contrast to this, in 1936, only 330 cases were officially reported to the authorities of about a dozen states having a total population of 84,000,000. There are several reasons for this wide divergence. In many of the cases the infestation results in such slight symptoms that they are entirely overlooked by the patient and no physician is called. Moreover, the symptoms are frequently regarded as

grippe, or muscular rheumatism or other ailment, and the true diagnosis is not made. Furthermore, physicians frequently do not suspect trichiniasis, and therefore omit examining the patient's blood microscopically. The recognition of the condition is facilitated when a group of cases develops simultaneously, or when death results from a severe infestation.

A common source of human infestation are pork products which have been merely smoked and then eaten without cooking. In pork packing plants supervised by the U. S. Bureau

Fig. 66.—Adult Trichinella spiralis (♂ , male; ♀ , female), from the duodenal contents of a white rat, ten days after infection, as seen under the low power of the microscope (Rivas).

of Animal Industry the pork to be used for such smoked products, *e. g.*, salami, cervelat wurst, pork roll and tee wurst, must previously have been refrigerated for thirty days, a procedure which kills the trichinae which may be present. The enumeration of the various products just mentioned indicates why cases of trichiniasis are more prevalent among Germans and Italians than they are among native Americans. Unfortunately, federal supervision does not include small packing establishments and smoke houses engaged only in

local, intrastate business, so that these may use trichinous pork which has not been refrigerated for one month.

Numerous studies have shown that the incidence of trichinella infestation in hogs depends on the manner in which the hogs have been fed. Thus, Hall of the U. S. Public Health Service says:

"Garbage-fed swine have trichinae between three and five times as frequently as do grain-fed swine, and hence are specially important as sources of human trichinosis.

"Trichinosis in swine is apparently traceable to the eating of uncooked pork scraps in garbage, table scraps, swill, and similar things, much more often than it is traceable to the eating of rats by swine.

"The garbage-feeding industry, as ordinarily carried on, is dangerous to the health of man and livestock, esthetically objectionable, and often economically unsound."

In 1928 Bachman* devised an ingenious *skin test* by means of which trichinella infestation in hogs could easily be determined preparatory to slaughter. Experience has shown that the test is simple, rapid and accurate. It may be that health authorities can devise practicable administrative measures whereby this test can be insisted upon in hog slaughtering.

In order to avoid trichiniasis the safest plan is to refrain from eating pork which has not been thoroughly cooked, and to purchase smoked pork products which are to be eaten uncooked, only when they have been processed by reputable packing establishments operating under the supervision of the U. S. Bureau of Animal Industry.

FILARIASIS

Filariasis is a disease of tropical countries due to infestation with various related worms of the genus *Filaria*. The larval form of these worms is found in the blood of patients, and for a long time was the only form known. For this reason the parasite was called "Filaria sanguinis-hominis," and later became known as *Filaria bancrofti* or *Wuchereria bancrofti*. We now know that the adult worm has its proper habitat in man in one of the lymph passages, usually in one of the large lymph vessels of the groin or in the thoracic duct. At

* Journal of Preventive Medicine, 2, 1928.

this place the female gives birth to a large number of larvae which eventually make their way into the blood. Since the adult male worms measure about 40 mm. and the adult female almost double this, and since, furthermore, a male and female worm usually lie intimately coiled together, it

Fig. 67.—Filaria in human blood (Rivas).

will be readily understood that they may give rise to serious obstruction in these lymph passages. The result of this obstruction is the condition known as "elephantiasis," characterized by a marked swelling of the legs.

Filariasis is transmitted from man to man by the bites of Culex and perhaps also of Anopheles mosquitoes.

PART III. IMPORTANT NONCOMMUNICABLE DISEASES AND CONDITIONS

CHAPTER XXII

DISORDERS OF NUTRITION

Malnutrition is a common disorder, especially in children. In the majority of cases it is directly traceable to poor personal hygiene. Improper food or insufficient food, nervous exhaustion from overwork, worry or dissipation, lack of sunshine and fresh air, and lack of exercise are common causes. In adults with a comfortable standard of living the improper food may denote too much food rather than too little. In some cases the cause of malnutrition may be some poisoning of the system by disease germs found in diseased tonsils or in abscessed teeth, tuberculosis of the lungs or glands, syphilis, malaria, hookworm, etc. Occasionally the cause may be kidney disease, by which excretion of waste products is decreased. While heredity undoubtedly plays some part in determining the general build of a person, it must be emphasized that in most cases of malnutrition there is a removable cause and that it is most important to discover what this is.

Malnutrition manifests itself principally by *underweight,* by *anemia,* shown by pallor of the skin and mucous membranes, by *poor nerve-muscular tone,* shown by listlessness and relaxed muscles, and by flabby, soft muscles and tissues.

The prevention and treatment of malnutrition consist in the removal of the responsible causative factors (attention to foci of infection, etc.), and in general hygienic measures.

Obesity.—One of the most common disorders of nutrition is obesity. This is much more than an inconvenient accumulation of fat tissue in the body; it is a menace to health. The experience of life insurance companies shows that the obese have a distinctly lower expectation of life than normal indi-

viduals. In some instances the condition seems to be hereditary; in the majority of cases, however, it is the result of a sedentary life associated with *overeating*. As the fat tissue accumulates it interferes with muscular exercise, both directly and indirectly, for the deposit of large masses of fat causes shortness of breath on exertion. A vicious circle is thus established, the lack of physical exercise causing the obesity to increase.

A glance at any of the many trash magazines, especially those which cater to women readers, shows the enormous amount of misleading and often vicious advertising devoted to treatments for obesity. The gullible are promised quick reduction of weight, "without discomfort," through the use of some special tablets, or salts, or baths, or some sweat box. "You can eat what you like" is the bait of some of these fakers. That these various treatments yield handsome monetary returns to the advertisers is a sad commentary on the intelligence of a large part of the population.

Reduction treatments should never be carried out except under the supervision of a qualified physician.

Diabetes Mellitus.—Initiated by the studies of von Mehring and Minkowski in Europe, carried further by Opie in this country, and culminating in the work of Banting in Canada, scientific research has given us a clear conception of the nature of diabetes. It is now well established that the essential feature of the disease is a disturbance of the function of the pancreas. Normally the pancreas secretes a hormone, *insulin*, which is necessary in the oxidation of sugars in the body. In diabetes there is an insufficient secretion of insulin, so that considerable amounts of the sugars pass into the blood unchanged, amounts far greater than the individual can tolerate. As a result of this, sugar passes into the urine, a condition known as *glycosuria*. Because of the inability to utilize a large part of the carbohydrates in the food the patient loses weight, becomes weak and emaciated, suffers from thirst, and, in severe cases, dies of starvation, or as a result of complications. Prior to the discovery of insulin in 1922 the only way to treat diabetics consisted in reducing the amount of carbohydrates (sugars and starches) in the diet,

increasing the amounts of protein and fat, and perhaps reducing the entire food intake almost to the point of a starvation diet. By the administration of insulin in suitable doses it is now possible to include an adequate amount of carbohydrate in the diet and maintain the patient in a relatively normal state of nutrition. Among the preventive measures special attention should be given to the prevention of obesity, for this condition is prone to lead to the development of a latent diabetes. (See also Chapter XXIV.)

Scurvy.—This is a disease of nutrition due primarily to the lack of a specific vitamin. Our chief interest in scurvy at the present times lies in its frequent occurrence in artificially fed infants.

Scurvy is usually caused by a diet deficient in fresh fruit and vegetables containing vitamin C. A characteristic of this vitamin is the fact that it cannot be synthesized by animals, but is derived solely from the vegetable world. This means that cows' milk may be rich or poor in this vitamin according to the nature of the fodder, and that the quality of the milk which the baby obtains at the breast depends on the mother's food.

Scurvy is marked by *hemorrhages* into the skin, muscles, gums, and under the periosteum. The gums become spongy and the teeth loosened. The patient becomes tender to touch. In infants this tenderness is one of the early signs.

The prevention of scurvy is simple, and consists merely in providing in the diet a sufficient quantity of antiscorbutic foods, in other words, fresh fruits and fresh vegetables. Among the fruits, lemons and oranges are the most valuable; among the vegetables, cabbage, tomatoes and potatoes. Experience has shown that canned tomatoes (strained) serve the purpose as well as raw tomatoes, tomato juice or orange juice.

Rickets (*Rachitis*).—This is a nutritional disorder of infants marked by alterations of the bones, especially of their growing ends. The development of rickets is due to both improper diet and faulty hygiene. Rickets can be produced in animals by a diet deficient in vitamin D.

The greatest recent advance in our knowledge of rickets is an understanding of the nature of the hygienic factor. This

has been found to be *sunlight,* rather than fresh air, or exercise, or cleanliness. It is now established that sunlight acting on the skin causes the development of a substance apparently identical with vitamin D. The effect is produced by the ultraviolet (invisible) and not by the visible rays. These ultraviolet rays do not penetrate window glass, so that a baby can receive none of their protective and curative properties if it is kept in a room with the window closed.

The ultraviolet rays can also be furnished by a mercury vapor arc lamp (*air cooled*) or by a carbon arc lamp. Whether direct sunlight or an ultraviolet lamp be used, the skin of the entire body should gradually be irradiated until it becomes tanned.

Cod liver oil has marked antirachitic properties, and has therefore been termed "bottled sunshine." Hess, who did a great deal of valuable work on rickets, advised the giving of cod liver oil to all babies as a routine practice. In addition to this he urged that infants be kept out of doors as much as possible and not shielded from the rays of the sun; their arms and legs may be exposed while their bodies are protected against the cold. In the case of premature infants it is often of value to combine the administration of cod liver oil with irradiation treatment.

Our knowledge of vitamin D has been greatly increased in recent years. The chemical constitution is known and it is now possible to prepare the vitamin in pure form. Besides this, vitamin D can be generated in milk, vegetable oils and other foods by irradiating them with ultraviolet light rays. It has also been found practicable to increase the vitamin D content of cows' milk by feeding the cows with irradiated yeast. At the present time, therefore, there are available a number of common foods having a substantially increased content of vitamin D.

Pellagra.—This is a disease generally attributed to a food deficiency, and is characterized by skin lesions, gastrointestinal disturbances, and nervous and mental changes. It is common in southern Europe, Egypt, India, Central America, the West Indies, and to some extent in the southern part of the United States. The term "pellagra" means "painful

skin." The researches of Goldberger of the United States Public Health Service did much to classify pellagra as a nutritional disease due to a faulty diet, one deficient in a specific vitamin. At one time this was designated as vitamin G. It is now known that it is a member of the complex originally known as vitamin B, and chemists have identified it as nicotinic acid. Some nutritionists speak of it as vitamin P-P, a convenient designation denoting "pellagra preventive."

Pellagra appears often to develop on the basis of some other disease, such as hookworm, malaria, tuberculosis or syphilis. For this reason preventive measures must take account of these underlying disorders. So far as diet is concerned, it should be general, varied, and well balanced as regards the proportion of protein, carbohydrates and fat. Meat, eggs and milk are essential but should be supplemented by vegetables and fruits.

Beriberi.—This is a deficiency disease due to the lack of vitamin B_1 in the diet. It is characterized by multiple neuritis, edema, and cardiac weakness.

The specific vitamin, vitamin B_1 (thiamin), whose deficiency is responsible for the development of beriberi, is soluble in water. It is present in the bran layers of cereal, in peas and beans, in yeast, milk, eggs and various meats. Beriberi is prevalent in the Orient because there a monotonous diet of polished rice (*i. e.*, from which the external layer has been removed by milling) is the rule for a large part of the population. There is no danger of developing the disease merely from eating polished rice, provided the diet is varied and the vitamin is present in the other foods.

Beriberi can readily be prevented, though in the Orient, among the ignorant masses, the problem can only be solved by a slow process of education. This is rendered the more difficult by racial food habits and extreme poverty.

In certain institutions in the United States the occurrence of beriberi has resulted from a too exclusive restriction of the diet to white bread and molasses. In these cases whole wheat bread should be substituted for white bread made from highly milled flour. (See Chapter VII, page 71.) Beans, peas or some similar legume should be served at least once

a week. Whole barley should be used in soups; and fresh meat, milk and eggs should be served as freely as possible.

Food faddists, charlatans and nostrum makers have utilized the facts presented above in order to impress on the laity the alleged virtues of their special systems or nostrums. The reader is referred to Chapter VII for guidance concerning the essential requirements of a healthful diet.

CHAPTER XXIII

OUR CHANGING HEALTH PROBLEMS

A CENTURY ago, with very little real knowledge of the causes of disease, efforts to protect the public health consisted chiefly in the sanitary improvement of the environment. Attention was centered on such matters as water supply, the cleaning of streets, the disposal of filth and rubbish, and the control of offensive trades. During the seventies and eighties, following the demonstration that many prevalent diseases were caused by germs, medical science assumed the leading rôle. Under its influence the character of public health work underwent marked changes, and many new fields were opened up.

To better understand the enormous difference between present-day health problems and those faced by health administrators fifty and sixty years ago, it will be helpful to consider briefly the three principal factors which brought about these changes, namely, (1) the successful control of major infectious diseases, (2) medical progress in other fields, and (3) the aging of the population.

Successful Control of Major Infectious Diseases.—From what has been said in previous chapters it will be clear that medical science has made notable conquests of disease. One has but to glance at mortality tables to realize how much has been accomplished, especially since the introduction of bacteriology. The table on page 192 may serve as an example.

In connection with this table the senior author likes to recall the description of medical practice during the later decades of the nineteenth century once given him by his former teacher, Dr. Abraham Jacobi, one of the great physicians of his time: "We doctors were always busy. With the coming of hot weather there were innumerable cases of cholera infantum and malaria, and beginning about August we saw many cases of typhoid fever. All this kept us busy into the fall. After the schools had opened, diphtheria, scarlet

SOME MAJOR CAUSES OF DEATH, NEW YORK CITY, 1880 AND 1940

Disease.	1880		1940	
	Number.	Rate.	Number.	Rate.
"Cholera infantum" (Children under 2 yrs.)	2,964	245.1	248	3.4
Diphtheria	2,300	190.2	10	0.1
Scarlet fever	618	51.1	14	0.2
Whooping cough	277	22.9	49	0.7
Smallpox	31	2.6	0	0.0
Typhoid fever	372	30.8	14	0.2
Phthisis (pulmonary tuberculosis)	4,706	389.2	3,319	45.0
Pneumonia and bronchitis	4,197	347.1	3,407	46.0
Cancer	659	54.4	12,294	166.3

Note: All rates are per 100,000 of the entire population.

fever, measles and other children's diseases became prevalent. Winter brought smallpox, pneumonia, meningitis and sometimes typhus. We never could get a real vacation."

It is clear, from this description and from the comparison of conditions shown in the table, that there has been a great change in the relative importance of our health problems, and that the successful control of many infectious diseases has been a potent factor in this change.*

Medical Progress in Other Fields.—But medical science has made notable advances also in other fields and these too have played an important part in shifting our emphasis on health problems. Most of them represent the result of scientific research since the turn of the century. The following examples may be cited:

The work of Chittenden, Lusk and others furnished a wealth of basic information in the field of nutrition, and gave us a deeper insight into the quantity and kind of protein which should be provided in the human diet. From Chittenden's

* In this connection one cannot but admire the unique fact that the medical profession has ever devoted a large part of its efforts to reducing the source of its livelihood, the prevalence of disease. In doing so the disciples of Æsculapius have lived up to their noblest and most cherished traditions.

laboratory also came the observations by Mendel that oleomargarine was not the equal of butter in the diet. Then came the brilliant work of Funk who first described the accessory food substances known as vitamins, a discovery which opened up a new and important field in the chemistry of nutrition. The influence of this new knowledge on the prevention and treatment of disorders of nutrition has been enormous. It must be admitted, however, that malnutrition, traceable, not to a lack of food, but to improper diets, is still widespread throughout this land of plenty, and that it is the exception to find health departments devoting the attention to the control of the situation which this prevalent and largely preventable disorder deserves.

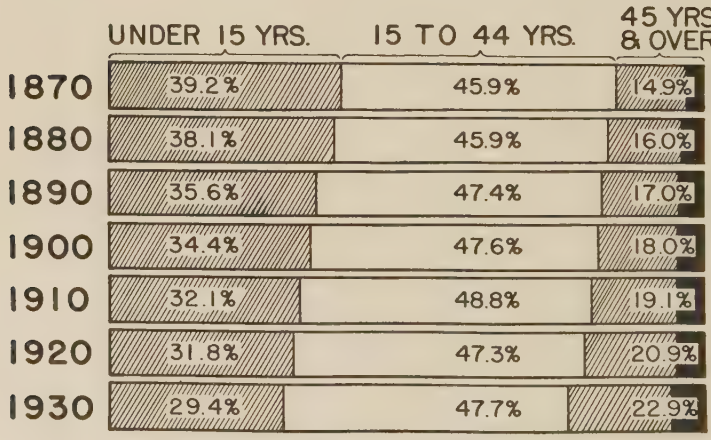
A second example is *dental caries,* without doubt the most prevalent defect of civilized man. For centuries regarded as one of "the ills that flesh is heir to," it has only recently been regarded as a public health problem deserving serious attention. Over a quarter century ago the significance of dental caries as a focus of infection was clearly recognized, and attempts were made to deal with the problem. Unfortunately sufficient scientific knowledge regarding the causes of dental caries was not then available, and campaigns for regular brushing of the teeth were carried on with the promise "a clean tooth never decays." The results were disappointing. Now, with the knowledge of the part played by diet, especially by the various vitamins, plus an appreciation of the importance of treating cracks, fissures and minute cavities in the teeth of young children, health authorities have the means to deal effectively with dental caries. The magnitude of the undertaking is enormous, but the responsibility must be faced.*

As a final example of a health problem which deserves more attention because of greater scientific knowledge now available, we mention *hay fever,* especially the very prevalent fall hay fever. Many thousands of victims of this condition continue to be made miserable each year, through the failure, on the part of health authorities to deal effectively with ragweed, whose pollen is the chief causative factor of this dis-

*See the chapter by Strusser in "Principles and Practice of Public Health Dentistry," J. A. Salzmann, D. D. S., Editor. The Stratford Co., Boston, 1937.

order. Our C.C.C. camps have been diligently grubbing out the intermediate hosts of the virus of blister rust in order to protect our pine forests, but ragweed is still allowed to flourish in the vacant lots of our cities and along our country roadsides.

Influence of the Aging of the Population.—Thus far we have discussed two important factors which have led to a change in our health problems. There is a third, perhaps the most important one, namely the marked decline in the birth rate during the past fifty years. Because of this decline, the



(1) SOLID BLACK INDICATES 65 YRS. AND OVER

Fig. 68.—Age distribution, population of the United States.

proportion of children in our population is decreasing while the proportion of older persons is increasing. This is well shown in the accompanying graph.*

With this marked change in the age distribution of the population it is clear that, apart from any other factor there should be fewer cases and deaths of the diseases of childhood,

* As this edition goes to press the Bureau of the Census has made available the age distribution revealed by the 1940 census enumeration. The figures are as follows: Under 20 years 34.5 per cent; 20–44 years 39.0 per cent; 45 years and over 26.5 per cent. Included in the last is the group 65 years and over 6.8 per cent.

and more cases and deaths of the diseases associated with later life.

We have already discussed the diseases of childhood and have observed that advances in medical knowledge have also contributed much to their reduction. In contrast to this the diseases of later life still present baffling problems. Included in the group are diabetes, cancer and chronic diseases of the heart, arteries and kidneys. With the exception of diabetes, all frequently give rise to serious disability and premature death. In the case of diabetes this is true only of the untreated cases.

It must, of course, be recognized that the span of human life is limited. All that we can hope to accomplish is to have as large a proportion of persons live out the full life span in comfort and in the enjoyment of their faculties. Since most of the diseases mentioned often give rise to considerable suffering and disability, medical science has devoted very considerable attention and effort to the discovery of effective control measures. With the exception of diabetes, progress has thus far been slow.

We continue the discussion in the next three chapters.

CHAPTER XXIV

CHRONIC DISEASES OF LATER LIFE

DIABETES

In medical textbooks published sixty or seventy years ago, diabetes was spoken of as a rare disease, more common among men than among women. We now know that at present the disease is very common and that it is more prevalent among women than among men. There is good reason to believe that it was always a prevalent disease, but that it was not recognized. Its more frequent discovery among males a generation or two ago is probably explainable by the then much greater proportion of males among the applications for life insurance, in connection with which the applicant's urine was tested for sugar.

Inasmuch as diabetes is not a reportable disease, no figures are available as to its *prevalence*. There is good reason to believe, however, that there are over half a million diabetics in the United States. It has been estimated that in New York City the number of diabetics lies between 50,000 and 100,000. So prevalent a disease constitutes a distinct and important health problem. It deserves special attention because through proper medical care diabetics can lead a normal life, attend to their affairs without invalidism, and usually live out the average life span.

Diabetes results from the complete or partial inability of the body to utilize sugars and starches in the diet. These, the "carbohydrates," as they are called, are indispensable foods. No matter what kind of carbohydrate is ingested in the form of food, it is always transformed in the body into glucose, in which form it is poured into the blood stream and brought to the body cells. In normal individuals a secretion produced in the pancreas, called *insulin,* enables the body cells to utilize this glucose as food, and it also makes possible the conversion of unused glucose into glycogen for storage

in the liver. In the diabetic there is a disturbance of this insulin secretion, hence the glucose cannot be utilized by the body cells, nor can it be converted into glycogen. Consequently the glucose accumulates in the blood, and following this it is excreted through the urine. To dissolve the glucose and excrete it through the kidneys demands a considerable amount of fluid. Hence there is thirst and the excretion of large amounts of urine. Moreover, because the body cells do not get sufficient glucose for nourishment there is loss of body weight.

In 1921 Banting and Best, working in the laboratories of the University of Toronto, devised a method of preparing stable preparations of insulin from the pancreas of slaughter-house animals. The use of insulin has revolutionized the treatment of diabetes and has enabled many thousands of diabetics to live a normal, active life. Insulin is effective only when given by hypodermic injections; it is destroyed when taken by mouth. This has resulted in an unwarranted prejudice against insulin, many ignorant persons associating the use of a hypodermic syringe with narcotic addiction. Public health workers have a definite responsibility in educating the public regarding the value of insulin and the need for administering this valuable agent hypodermically.

Slow acting modified insulins, such as protamine-zinc insulin, have recently come into extensive use. Their action is prolonged, consequently they need to be administered less frequently than regular insulin and are less objectionable to the patient.

Since the introduction of insulin the lives of diabetics have been distinctly lengthened. This is well shown in the table (p. 198) showing the median age at death of the diabetes deaths registered in New York City.

This table shows that in the seventeen pre-insulin years, the median age at death for males increased only 1.4 years, while that for females even showed a slight decrease. In contrast to this, during the seventeen years with insulin treatment available, the median age at death of males increased 5.5 years, and that of females 4.4 years.

While diabetes is most common in persons over forty, the condition occurs at *all ages*. In children it is about equally

DIABETES: MEDIAN AGE AT DEATH

New York City, 1906–1922 and 1923–1939 incl.

Before Insulin			*With Insulin*		
Year.	Male.	Female.	Year.	Male.	Female.
1906.....	56.8	60.5	1923.....	58.8	60.4
1907.....	56.9	60.7	1924.....	59.9	60.9
1908.....	57.2	59.8	1925.....	60.5	61.2
1909.....	57.1	58.5	1926.....	60.9	61.7
1910.....	57.2	58.5	1927.....	61.0	61.7
1911.....	57.0	59.1	1928.....	61.0	61.9
1912.....	57.4	59.6	1929.....	61.1	62.1
1913.....	57.5	59.8	1930.....	61.7	62.5
1914.....	57.8	59.4	1931.....	62.2	62.7
1915.....	57.8	59.2	1932.....	62.3	62.8
1916.....	57.8	59.6	1933.....	62.6	63.2
1917.....	57.8	59.7	1934.....	62.6	63.6
1918.....	57.3	59.5	1935.....	63.0	63.9
1919.....	57.7	59.5	1936.....	63.2	64.1
1920.....	57.6	59.4	1937.....	63.6	64.3
1921.....	58.1	59.7	1938.....	64.0	64.6
1922.....	58.2	60.0	1939.....	64.3	64.8

Note: In order to minimize the effect of chance fluctuations, the series of annual rates has been smoothed by means of a three-point moving average beginning with the year 1904.

prevalent in the two sexes. In adult life however, women diabetics are twice as numerous as male diabetics.

Diabetes is much more prevalent among Jews than among non-Jews. Studies made by the senior author indicate that in New York City the disease is 75 per cent more prevalent among Jews. In Berlin, similar studies by Wolff showed an excess prevalence of 60 per cent among Jews. The cause of this greater prevalence is not clear.

Heredity appears to play a prominent rôle in the development of diabetes. According to Joslin the diabetic factor is recessive and its hereditary transmission follows the Mendelian laws. Diabetics should not marry diabetics.

Obesity is another important factor in diabetes, though its mode of action is not clear. In the presence of an inherited tendency, obesity seems to cause the latent condition to become active.

If one correlates diabetes mortality rates with *marital condition* of the deceased, still another factor appears to play a part in diabetes. This correlation was first brought to notice

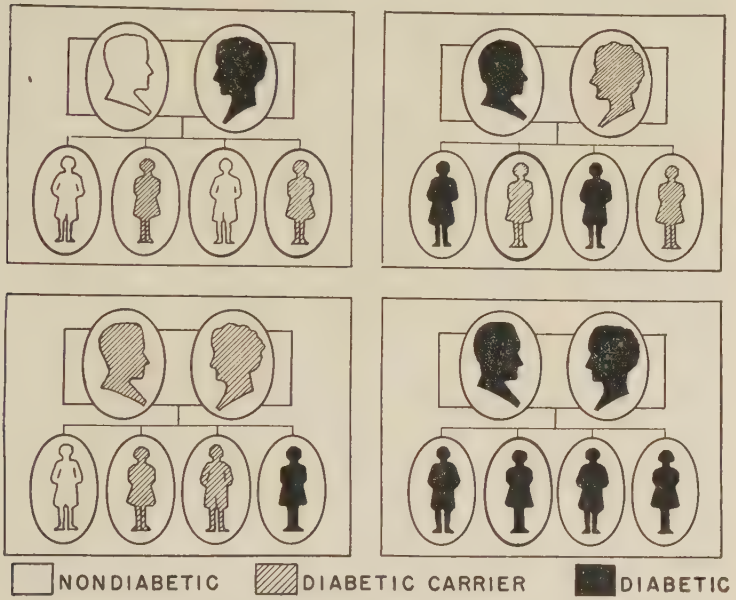


Fig. 69.—Heredity in diabetes.

by Bolduan in the following table based on New York City's mortality records for 1931 and 1932:

DIABETES DEATH RATES, PERSONS FORTY-FIVE YEARS AND OVER, BY MARITAL STATUS

	Single		*Married and Widowed*	
	Male.	Female.	Male.	Female.
Deaths, average of 2 years	63	53	547	1,196
Population, persons 45 and over	82,494	82,450	644,285	643,827
Death rate, per 100,000	76.3	64.3	84.9	185.7

It will be seen that among the single persons forty-five years of age and over there is no great difference between the mortality rate of males and females. Among the married and widowed males deaths from diabetes are about 10 per cent higher than among the single males. Among the married and widowed women, however, the diabetes death rate is nearly three times that among the single women of the same age group. This suggests that pregnancy may be a factor in the development of diabetes, pregnancy being known to give rise to endocrine disturbances.

Before the introduction of insulin, *pregnancy* in a diabetic was associated with great danger. Moreover, the diabetic children born had only a very short life span, usually dying within a year or two after the development of the disease. Today with the help of insulin the picture has changed. Diabetic mothers can be carried safely through pregnancy and children developing diabetes can be brought to adult life without invalidism due to their diabetes. Consequently the proportion of children diabetics is gradually increasing.

Diabetics are, of course, subject to the same chance of developing conditions requiring surgical treatment as are non-diabetics. In the former, however, the operative risks are far greater. Besides this, because of the arteriosclerosis which so often develops in the legs of patients with untreated or neglected diabetes, there is frequent need of amputations. Successful surgery in diabetic patients demands the closest teamwork between the surgeon and the physician treating the diabetic condition.

The *prevention of complications* requiring surgical treatment demands careful attention on the part of the patient to personal cleanliness, to special care of the feet, to the avoidance of cuts and bruises, to care in the use of hot water bottles, and the like.

Control Measures.—In the control of the disease our chief efforts should be directed (1) to the physicians, so that they will come more and more to make routine examinations of the urine of their patients in order to discover diabetes, and (2) to the general public, so that patients will place themselves under the care of a qualified physician and not resort to patent nostrums or self-medication.

Through the efforts of the senior author, New York City was the first to deal with diabetes as a public health problem. With the aid of a special committee appointed by the Academy of Medicine the New York Diabetes Association was organized in the fall of 1934.* Following are some of its major activities:

Cooperating closely with the Department of Health, the organized medical profession, the municipal and voluntary hospitals, and with unofficial health agencies, the Association has awakened a wide interest in the control of diabetes.

Through the organization of lectures, clinical conferences, and refresher courses, and the publication of leaflets dealing with specific clinical phases of the disease, it has helped to familiarize physicians with recent advances in the management of diabetes.

By means of popular exhibits and lectures for the laity, radio broadcasts, articles in newspapers and magazines, and pamphlets giving helpful information on diabetes, it has carried on valuable education to make the general public realize the prevalence of diabetes and the importance of proper medical treatment.

The Association has made grants to support clinical, statistical and other scientific research in the field of diabetes.

Finally, it has operated a free summer camp for diabetic children from families in low income groups, for such children cannot be accepted in the usual summer camps for normal children.

The example set by New York City has been followed by a number of other progressive cities, and health departments generally are coming more and more to interest themselves in the control of diabetes.

* The undertaking was made possible by financial support generously given by Mr. Lucius N. Littauer, to whom the senior author is happy to record his thanks.

CHAPTER XXV

CHRONIC DISEASES OF LATER LIFE (Continued)

CHRONIC HEART DISEASE

Chronic heart disease is the leading cause of death in persons over forty years of age. Once the disease is well established it progresses, slowly in some cases, rapidly in others, but almost always shortening the normal life span. In most cases there is no treatment which will restore the affected heart to its normal condition. Until comparatively recent times, even physicians were skeptical regarding measures to deal with heart disease as a health problem. Thanks to such organizations as the American Heart Association, a much more hopeful attitude now prevails. The interest aroused in heart disease by this and similar groups has resulted in a vast amount of valuable research, and has, in turn, already borne fruit in a better understanding of the various forms of heart disease and in an improvement and extension of the facilities for aiding those handicapped by heart disease.

Many different conditions may give rise to heart disease. Infections of various kinds play a prominent part. Often the heart affection occurs in childhood, and in these cases *rheumatic fever* is the most common cause. The nature of rheumatic fever is still obscure; hence but little progress has been made in devising preventive measures. Chorea, *i. e.*, St. Vitus' dance, appears to be a manifestation of rheumatic infection, and many cases of heart disease in childhood develop following this disease. In other cases the heart involvement is traceable to infections apparently entering through the tonsil. These youthful forms of heart disease affect chiefly the valves of the heart. In the fatal cases the deaths are usually found charged to *endocarditis* and to rheumatic heart disease. Of all the deaths charged in the mortality tables to some form of heart disease, approximately one-eighth are ascribed to the two designations just men-

tioned. Over 50 per cent of this eighth represent deaths before the age of fifty years.

Another important infection giving rise to heart disease is *syphilis*. This form of heart disease manifests itself in later adult life and affects chiefly the vessels and substance of the heart itself. Experienced cardiologists estimate that in the United States syphilis is at present responsible for about 5 per cent of all the deaths charged to heart disease.

In a large proportion of cases heart disease is part of the degenerative changes in the cardio-arterial system which are common with advancing age. The laity has come to recognize this under the term "hardening of the arteries" (*arteriosclerosis*). When these degenerative changes affect the arteries of the heart, as they often do, the nutrition of the heart suffers and the heart finds it difficult to carry on. Shortness of breath on exertion is one of the early symptoms of all cardio-vascular disease. Paroxysmal attacks of severe cramp-like pains in the heart, called "angina pectoris," are often distressing. Sudden death is common. This does not end the varieties of different conditions giving rise to heart disease. There is also a considerable group of cases in which the nerve centers in the heart, which control the heart's action, are involved.

During the decade 1920 to 1930 health authorities in this country became alarmed over the increasing number of deaths *registered* as due to "heart disease." Closer analysis* of the general death toll revealed that this rise was due, among other factors, to changing diagnostic fashions. Deaths which thirty years ago would be ascribed to "apoplexy," "chronic Bright's disease" or "senility" were now being called "hypertensive heart disease," "arteriosclerotic heart disease," "chronic myocarditis," etc. Pathologically this whole group of diseases is best spoken of as the *cardio-arteriorenal* or *cardiovascular* diseases, for disease in one part of the vascular system usually brings about secondary changes in the others. The clinical manifestations may be varied but, considered broadly, the fundamental processes are interwoven. It is best for us to consider the cardio-arteriorenal diseases

* Is the "Appalling Increase" in Heart Disease Real? Charles Bolduan and Nils Bolduan, Jour. Preventive Medicine, vol. vi, 1932.

as a group in dealing with them from the public health standpoint. We have already touched upon the diseases of the heart and arteries. The diseases of the kidneys, which we may term the various forms of "Bright's disease" (acute and chronic nephritis, nephrosis, essential hypertension) concern us in two important respects. The inception of the acute forms is frequently associated with infectious conditions of childhood, *i. e.*, scarlet fever, acute and chronic tonsillitis, and others, and they are therefore amenable to some preventive measures. The chronic forms, including essential hypertension, not infrequently arise from the acute forms and as such are indirectly susceptible to some degree of prevention. The brunt of disability due to the chronic forms of Bright's disease falls on the young adult and middle-aged group of our population; for this reason this group is considered in this chapter. The student is urged, however, to review the earlier chapters dealing with scarlet fever and other streptococcus infections with the above considerations in mind.

Altogether then, in dealing with cardiovascular disease as a health problem, we have to deal with a large number of quite different conditions. Since preventive measures, in the present state of our medical knowledge, are still very limited, we must concentrate attention on providing, for the victims of cardiovascular disease, conditions of life which will enable them to avoid overexertion, so that the heart may not be overtaxed. The provision of suitable remunerative occupations is desirable; freedom from worry and excitement is important; living conditions that will reduce stair-climbing to a minimum are indicated. Since extremes of outdoor temperature throw an extra burden on the cardiovascular system, an equable climate is of great advantage. For the great mass of the patients the necessary change of residence is out of the question. It is encouraging to know that, in spite of the many difficulties, by attention to the requirements just mentioned the life span of the victims of cardiovascular disease has been increased.

CHAPTER XXVI

CHRONIC DISEASES OF LATER LIFE (Continued)

CANCER

In the following pages the term "cancer" is used in a broad sense as the equivalent of malignant growths. This is probably permissible in a general work as this. From a scientific standpoint, however, it is important to recognize that there are many different kinds of malignant growths, affecting different tissues, different age groups, and perhaps involving different causative factors. Progress in the prevention and treatment of cancer would be seriously handicapped if each variety were not carefully distinguished and studied separately.

Prevalence.—Cancer is a disease in which the tissues of certain parts of the body take on a lawless growth, *i. e.*, grow beyond their natural limits, and invade the surrounding tissues. Unless properly treated it runs a fatal course. Cancer is one of the most frequent of all causes of death, being responsible for over 150,000 deaths annually in the United States. On the basis of authoritative estimates this would correspond to about 450,000 cases of cancer in the United States at the present time. Since 1900 the number of deaths in this country reported as due to cancer has increased from 63 per 100,000 of population to 115 in 1938.

Cancer is almost exclusively a disease of adult life; for of the total number of deaths from cancer at all ages, about 98.5 per cent occur after the age of twenty.

Cancer appears in many forms, and may affect almost any organ or part of the body. The white races are apparently more susceptible to cancer than are the primitive races, such as North American Indians and Orientals, but statistics for the primitive races are inaccurate so that any clear comparison is out of the question.

Cancer of the breast and cancer of the ovary are more frequent among unmarried women; cancer of the uterus, on the other hand, more common among the married.

The following table shows the distribution of cancer deaths in the United States in 1938, arranged according to the various organs attacked and by sex:

DEATHS FROM CANCER—UNITED STATES, 1938

Seat of cancer.	Total.	Male.	Female.
All organs	149,214	69,857	79,357
Buccal cavity	4,931	4,030	901
Digestive tract and peritoneum	70,807	38,126	32,681
Respiratory system	8,121	6,065	2,056
Uterus	16,291	.....	16,291
Other female genital organs	3,944	.....	3,944
Breast	14,460	145	14,315
Male genito-urinary organs	13,539	13,539	.....
Skin	3,340	2,039	1,301
Other or unspecified organs	13,781	5,913	7,868

This table shows that cancer is much more frequently a cause of death among women than among men, and for the reason that the breast and female genital organs are often the site of cancers. When allowance is made for cancer in these locations one notes that the disease is far more prevalent among men than among women. It is particularly interesting to note that men have almost five times as much cancer of the mouth as women.

In an analysis of cancer deaths, the senior author has shown that while cancer mortality is generally higher among Jews than non-Jews, deaths from cancer of the uterus are significantly less frequent among Jewish women than among non-Jewish.* The reason for this is not known, but the difference may, perhaps, be related to the hygienic practices enjoined by the Mosaic code.

The Search for Its Cause.—During the past twenty years,

*"Causes of Death Among Jews and non-Jews," Charles Bolduan and Louis Weiner, New England Jour. of Medicine, Vol. 208, No. 8, 1933.

commissions and laboratories for cancer investigation have been established in many places in the United States, as well as abroad. In these centers research work has been done on the tumors of animals as well as on human cancer. The resources of chemistry, physics, physiology and biology, and the study of immunity reactions have been brought to bear upon the problem, and though the work has been carried on vigorously the ultimate cause of cancer is not yet known.

Many important facts, however, have been discovered, and the structure of our knowledge of the disease is gradually being built up. One of the results of this research work is that we now know many things that cancer is *not,* and useless expenditure in investigation along these lines has ceased. We know cancer is not due, in the sense that infectious diseases are due, to a parasite. We know that the influence of heredity in the incidence of cancer in human beings is so remote that this factor may, as a rule, be disregarded. We know that one form of cancer after another has been shown to be related to some kind of chronic irritation as a direct or indirect contributing factor. We know that cancer of the cervix, the lip, the tongue, the rectum, the stomach, and many of the forms of malignant disease of the external skin are all closely associated in their inception with some form of chronic and repeated *irritation.* The study of cancer in animals has gone far to support this idea of the origin of cancer, and the artificial production of cancer in the stomach of rats by feeding them with infested cockroaches (Febiger), and the production of sarcoma of the liver in rats by infesting them with Cysticercus (Wood) provide most striking proof of the relation of chronic irritation as a factor in the cause of cancer. It has also been shown in the laboratory that the rough compression and manipulation of a cancer are capable of setting its cells free to form metastases. From this we learn to use the utmost gentleness in the palpation of a tumor for diagnosis, as well as to avoid compression, dragging and all unnecessary trauma to cancer tissue during the operation for its removal. All of these facts we owe to the laboratory investigation of cancer. We may reasonably hope that the next decade will contribute as much or more information concerning this disease.

Treatment and Prevention.—In the great surgical clinics the technical details of the operative treatment of cancer of the different organs are constantly under investigation with a view to improvement and to greater effectiveness. For most of the common sites of cancer the operative technic of the so-called radical operation is practically standardized.

The site of origin and the mode of dissemination of cancer in the different organs are well known. Each standard operation aims to remove the tissues suspected of secondary involvement by a wide margin and without cutting into cancer tissue or scattering it broadcast in the wound.

So far as *x*-rays and radium are concerned, the best authorities agree that radiation must be regarded as a safe method of treatment only for superficial cancer of the skin, or for other forms of surface cancer which have been in existence only a short time.

No serum or vaccine treatment has thus far been developed which has been of real service in dealing with cancer. The same is true of drugs of various kinds, and of attempts to cure cancer by diet.

The early diagnosis of cancer holds out the best hope of cure. Unfortunately, in most cases, *the more certain the diagnosis, the less the possibility of cure*. Every effort must therefore be made to educate the public as to the significance of the earliest symptoms, to the end that prompt operation may entirely eradicate all cancerous tissue.

Special attention must be given to conditions which, experience has shown, are frequently the forerunners of cancer. Among these may be mentioned moles, fissures, chronic ulcerations and indurations, and the benign tumors. Prevention also demands the removal of sources of chronic irritation, for example, the removal of an ill-fitting tooth-plate which causes irritation of the gums; or the repair, as soon as possible, of the deeper lacerations of the cervix which usually occur at childbirth.

Control Measures.—Following the lead of Massachusetts, a number of state health departments are devoting considerable attention to cancer control activities. The Federal government has also entered the field, and in Canada the work of the Ontario department of health deserves mention. In a

recent report* by the last named, the economic importance of cancer is well brought out by showing that "excluding pregnancy and childbearing, cancer ranks third only to appendicitis and accidental injuries in both cases and days of care—being responsible for 5.1 per cent of *all* days of care among patients discharged or dying during the period."

From the fact mentioned in the beginning of this article, that the registered cancer mortality in the United States has risen from 63 per 100,000 of population in 1900 to 115 in 1938, one might conclude that cancer is becoming more prevalent at an alarming rate. Studies made by Bolduan and Weiner† indicate that much of this increase is due to better diagnosis of cancer, and the rest of the increase is accounted for by the aging of the population. The figures cited above must therefore not be taken at their face value.

A great deal of valuable authoritative information on all phases of cancer can be obtained from the American Society for the Control of Cancer, New York, and the reader will do well to familiarize himself with the many helpful pamphlets published by this society.

* "Fourth Annual Statistical Report on Cancer, Calendar Year 1939," prepared by the Division of Medical Statistics, Department of Health, Ontario.

† "Is Cancer Becoming More Prevalent?" Charles Bolduan and Louis Weiner, Amer. Jour. Cancer, vol. xxi, No. 4, August, 1934.

CHAPTER XXVII

ENDOCRINE DISTURBANCES

Many of the large glands in the body produce a secretion which can be collected from the duct of the gland. Examples of such glands are the liver, whose secretion, the bile, flows from the hepatic duct; the pancreas, which secretes the pancreatic juice; the parotid and submaxillary glands which secrete saliva; and the testes, which secrete semen. There are, however, many glands that have no ducts whatever, and from which the secretion cannot be obtained directly. These are the so-called "ductless glands." For a long time their function was obscure. Examples of the ductless glands are the thyroid, the adrenals, the thymus, the pituitary, and the pineal gland. We are gradually learning that these produce secretions which in some way enter the circulation and play an important part in regulating the body functions. We speak of these secretions as "internal secretions" or "endocrines," and now know that even some of the glands which have definite ducts, as, for example, the testes, produce such internal secretions in addition to the secretion which they empty through their ducts. Disturbances of various kinds are produced by the absence of these endocrines, or by the increase or decrease of the amount secreted.

Thyroid Gland.—A very prevalent abnormal condition of the thyroid gland is that known as *colloid goiter*. In this the thyroid becomes uniformly enlarged about the time of puberty. The condition is common in many parts of the world, especially in Switzerland and Bavaria, in certain valleys of the Himalayas, and in the United States in the region draining into the Great Lakes. This form of goiter is now known to be due to a deficiency of iodine in the water and food. Near the sea coast, where iodine is abundant in water and plants, this type of goiter is uncommon. Marine and his associates in Ohio showed that the prevalence of goiter

can be greatly reduced by administering iodine to school children in small doses twice a year. Equally good results have been obtained in Switzerland. The iodine may be administered as tincture of iodine in a little water, for several doses twice a year, or it may be given over longer periods in infinitesimally small doses by adding iodine to the public water supply, or by supplying iodized salt for table use.

The routine use of iodine is not entirely without danger, for in certain forms of thyroid disease it may produce symptoms of hyperthyroidism.

The disease known as *exophthalmic goiter* (Graves' disease, Basedow's disease) is an affection due to an overacting, probably abnormal, thyroid gland. It is often associated with a bulging of the eyeballs (exophthalmos), an increased action of the heart, nervousness and irritability. Since we know nothing of the cause of the pathologic changes in the thyroid gland, we have, as yet, no preventive measures to deal with this disease. In the treatment of the condition absolute physical and mental rest are indispensable. Surgical intervention is often successful.

The decrease or absence of the secretion of the thyroid gland leads to the condition known as *myxedema.* The condition invariably follows complete removal or destruction of the thyroid gland either by operation, inflammation or atrophy. There is a gradual slowing of the mental and body activities, increase in weight, decreased appetite, and a peculiar change in the facial expression. The skin becomes dry and there is a peculiar edema. The speech is thick and slow, and the mentality becomes sluggish. Myxedema responds rapidly to treatment with thyroid extract, or dried sheep's thyroids, so that in a few weeks the patient may be restored to a normal condition.

Another condition due to more or less complete lack of thyroid secretion is *cretinism,* a disease originating during the fetal stage or in infancy. It occurs in regions where endemic goiter prevails, and is apparently caused by the lack of iodine in the mother's organism during pregnancy or shortly after. The disease is rare in the United States. Cretins develop very slowly and the intelligence is much below the normal. Many of them are unable to say more than a few

words, and are uncleanly in their habits. Some cretins develop a clownlike intelligence and are good humored, preserving a perpetual childhood. In order to prevent cretinism it is important to give iodine to all pregnant women in districts where endemic goiter prevails.

Pituitary Gland.—The pituitary gland is a small gland about the size of a hazelnut kernel, which lies at the base of the brain. It consists of an anterior and posterior lobe, each of which has separate and distinct functions. The anterior lobe is definitely related to the growth of the bones and the development and function of the genital system. *Gigantism,* a condition in which the height of the affected individual is more than 79 inches, and *acromegaly,* another disease characterized by an overgrowth of bone, are due to an increased activity of the anterior lobe.

Besides the growth hormone the anterior lobe also produces a "gonadotropic" or sex-stimulating hormone called *prolan.* In females two varieties of this hormone are thought to exist, namely prolan A (follicle-maturing factor) and prolan B (the luteinizing factor). Normal non-pregnant women excrete small quantities of prolan in the urine, but only at the time of ovulation; at other times in the menstrual cycle prolan can usually not be demonstrated in the urine at all. In pregnancy there is a prompt and marked rise in prolan in the urine, demonstrable as early as a few days after the first missed period. This fact is the basis of the diagnosis of pregnancy by the Aschheim-Zondek and the Friedman tests.

The anterior lobe of the pituitary is also intimately related to the functioning of the pancreas, and so plays a role in diabetes.

The posterior lobe in some obscure way controls the metabolism of fat in the body. It has been found that in from 70 to 80 per cent of the cases of *juvenile obesity* deficiency of the posterior lobe is a causative factor.

The Adrenals (*Suprarenals*).—There are two adrenal glands embedded respectively in the fat above each kidney. Each adrenal consists of a central portion and a cortex, which differ markedly from one another in their embryologic origin, their composition, and their function. The most obvious of the functions of the cortex is its influence upon growth and

sex differentiation. The abnormally large growth of hair on the face, chest, arms and legs, especially when it occurs in women, is associated with increase of the adrenal cortex. Sometimes the condition includes a recession of the feminine characteristics. Precocious puberty appears to be due in some instances to increased growth of the adrenal cortex.

The medulla of the adrenal is related to the sympathetic nervous system. Its active principle is epinephrine. Chronic insufficiency of the adrenal medulla produces the rare condition known as *Addison's disease.*

The Gonads.—The term "gonads" is applied to the sex glands. Both the ovary and the testes produce endocrine secretions. The former produces certain estrogenic hormones one of which, *estrin* (or *estrone* or *theelin*) manufactured principally by the graafian follicle supervises the first (proliferative) half of the menstrual cycle. The other, *progestin* (or *progesterone*), manufactured by the corpus luteum, governs the second (secretory) half of the menstrual cycle, and during pregnancy regulates the formation and maintenance of the decidua and placenta, and the proper preparation of the mammary glands and uterus. The production of both these hormones is intimately related to the hormones produced by the anterior lobe of the pituitary.

Increased activity of the gonads may result in precocity and abnormal increase in sex desire. The complete removal of the testes causes the condition known as *eunuchism,* the removal of the ovaries that known as the *menopause* (change of life, climacteric).

Infantilism is a condition of arrested development. Individuals with infantilism are adults in years, though still children in mind and body. All grades of this condition are encountered, hence one speaks of "universal" and "partial" cases of infantilism. Many of these are due to true endocrine diseases, that is, diseases of the thyroid, gonads, pituitary, or even other glandular structures.

Interrelationship of the Endocrines.—The internal secretions of the different glands mentioned above are all more or less intimately related to each other; though the relationship is very complex and far from being clearly understood. The relation to the sex glands seems to be especially close. We

know that a deficiency in some of the internal secretions may be compensated for by an increased secretion from another gland. In some cases symptoms primarily due to a disturbance of one of the ductless glands can be relieved by treatment with the extract of one of the other glands. Almost all of the internal secretions are also closely related to the sympathetic nervous system which controls the heart and the blood vessels.

An excellent presentation of this difficult and relatively new subject is "Endocrinology in Modern Practice," 2 Ed., by William Wolf, published by W. B. Saunders Co., Philadelphia, 1939.

CHAPTER XXVIII

MENTAL DISEASE AND MENTAL DEFICIENCY

From the remotest times people believed that the insane were "possessed," and that heroic measures were needed to drive out the evil spirits. It is true that the great Greek physicians, especially Hippocrates and Galen, laid down sound principles of dealing with the mentally deranged, but it is equally true that, in the Middle Ages and even well into the eighteenth century, little or nothing was done to care for these unfortunates. About 1750 the condition of the insane attracted attention in England, and from reports made at the time we learn that the "unfortunate inmates were immured in cells, chained to the walls, flogged, starved, and not infrequently killed." One of the madhouses in London, the notorious Bedlam, was regarded much the same as a museum of freaks, to which visitors were admitted to see the inmates. This state of affairs was brought to an end largely through the efforts of Tuke in England, and Pinel in France, two names inseparably connected with humane treatment of the insane.

Prevalence.—The number of persons afflicted with *mental disease* (psychoses) in one form or another is very great and the financial burden which they place on society is enormous. It is, however, impossible to give accurate statistics concerning the total number of persons who are mentally diseased, for no hard-and-fast line can be drawn between the mentally diseased and normal individuals. The total number of those suffering from psychoses and now confined in institutions for the insane amounts to approximately 250,000 persons in the United States, yet even that is undoubtedly far below the number who should have custodial care.

In addition to the persons suffering from psychoses (commonly spoken of as the insane) there is another large group of persons whose mental development is defective. This in-

cludes idiots, imbeciles and feebleminded. It is convenient to apply the term "mental defectives" to this class.

The total number of *mental defectives* is also very difficult to determine, for while idiocy, imbecility and feeblemindedness are readily recognized, the milder forms of mental deficiency often pass unnoticed. At present, special institutions in the United States house about 25,000 mental defectives, though it is estimated that about three or four times this number should really be cared for. Salmon, a recognized authority in this field, stated that not less than 3 in every 1000 of population were mentally defective. The total number in the United States would therefore be well over 300,000, of which about 100,000 are girls and women of child-bearing age. Three quarters of these are at large in the community.

Mental disease and mental deficiency are responsible for much personal suffering, unhappiness, crime, and social and domestic disasters. Even the less pronounced derangements and deficiencies bring the afflicted into all sorts of conflicts with laws and conventions.

In speaking of the mentally diseased it is well to avoid the term "insane," for this is a legal term which relates to such matters as testamentary incapacity, incompetence regarding the use of property, the right of forcible detention in institutions, and the like. In other words, persons with mental disease may or may not be "insane" in the legal sense. Instead of mental disease we may use the term "psychosis" (plural, psychoses).

The term "mental deficiency" is used to denote the various degrees of mental defect existing at birth or manifesting itself during the early period of life. Arranged according to the degree of deficiency the mental defectives are classed as idiots, imbeciles, and low- and high-grade morons.

Causal Factors.—In a large proportion of cases of mental disease it is impossible to determine the cause satisfactorily. In certain psychoses, *heredity* seems to be an important factor. This is especially true of the manic-depressive psychosis (the so-called "circular insanity"). It is not yet possible, however, to say what precise part inheritance plays. In about 50 per cent of all admissions to hospitals where careful records are made, a history of mental disease in the family was found.

The excessive indulgence in *alcohol* is the essential cause in the so-called "alcoholic psychoses," *i. e.*, delirium tremens, alcoholic hallucinosis, alcoholic deterioration, and others. So far as the other psychoses are concerned, for example, dementia praecox, paranoia and manic-depressive psychosis, it is not known to what extent alcohol is a causative factor. It must not be forgotten that in many psychoses overindulgence in alcohol may be a symptom and not the cause of the mental disease.

Syphilis is the essential cause of "general paresis," a psychosis responsible for about 13 per cent of all first admissions to hospitals for the insane. This disease is probably also a causative factor in some of the other psychoses, but to what extent cannot yet be established.

Other infectious diseases and intoxications (*i. e.*, puerperal) occasionally act as causative factors in producing psychoses.

Turning now to mental deficiency, we find that heredity plays by far the greatest rôle, for in about two thirds of the cases in which a satisfactory family history can be obtained, the influence of this factor can be clearly recognized. It is possible that alcoholism in the parents is also a factor, but the evidence is not conclusive. Syphilis is an infrequent cause of mental deficiency. Gross injury to the brain during birth or in infancy and early childhood seems to be responsible for some cases.

Prevention.—From what has been said it is clear that the formulation of preventive measures against mental disease and mental deficiency is difficult. As in so many other diseases which we have already discussed, our greatest problem is that presented by the mild, atypical cases. In the first place, these are the ones which frequently fail to be detected and, secondly, even when they are recognized, our means of dealing with them are often very limited. It is difficult to have the patients committed to institutions for custodial care; therefore many of them remain at large in the community, free to procreate their kind. In the case of mental defectives who have come into conflict with the law, some states have adopted the plan of sterilizing the individuals by means of a surgical operation on the vas deferens in the male or on the

fallopian tubes in the female. This method, however, has not found wide acceptance.

The prevention of general paresis and other psychoses in which syphilis is the causative factor resolves itself into the measures which have already been discussed in connection with venereal diseases. The same holds true for the small group of cases in which the poisons of the infectious diseases and other intoxications play a part.

Finally, it must be remembered that many children who have a sensitively developed nervous system, *i. e.*, a very labile mental constitution, may develop either into entirely normal adults or into psychopaths, the outcome depending largely on their environment and on the methods of education and training to which they are subjected.

CHAPTER XXIX

HAY FEVER AND ALLIED CONDITIONS (ALLERGY)

The conditions here to be considered, of which "hay fever" is perhaps the most familiar example, are characterized by a peculiar sensitiveness on the part of certain individuals to substances which are entirely without effect in most other persons. The tissues of the sensitive persons react in a characteristic manner giving rise to a variety of distressing symptoms. This hypersensitiveness is spoken of as "allergy." The character of the symptoms depends on the nature of the offending substance and especially on the manner in which it is introduced into the body and on the tissues affected. When the offending substance reaches the body by inhalation, the symptoms are chiefly referable to the respiratory tract; when introduced by food they may consist of gastro-intestinal disturbances, but often show themselves in the form of annoying skin eruptions, especially urticaria; in still other cases chronic inflammations of the skin appear to be the result of direct contact of the offending substance with the skin of such allergic individuals.

Seasonal Hay Fever.—Hay fever is extremely common and, while not a dangerous condition, it is one that brings misery and discomfort to thousands of persons annually. By far the greater number of cases of such reactions are caused by pollens, the resulting symptoms constituting what is known as "seasonal hay fever."

In the eastern part of the United States three broad classes of seasonal hay fever occur. The *spring type* begins at the end of March or early in April and extends to the end of May. This is due almost entirely to the pollen of trees, especially that of the oak, elm, maple, birch and hickory. The second type, beginning at the end of May and extending to the middle of July, is generally caused by the pollen of grasses and is designated as the *summer type*. The important pollens of this group are timothy, red top, June grass, orchard

grass, sweet vernal and plantain. The third or *fall type* begins in the middle of August and continues until frost. The pollen of the ragweed is mainly responsible for this group.

The *symptoms* of hay fever are similar to those of a severe cold in the head, the reaction occurring principally in the mucous membranes of the eye, nose and throat. There is itching and congestion. Sneezing occurs in violent paroxysms, and is accompanied by a thin, irritating serous discharge. There may be great obstruction to nasal breathing. About 15 per cent of the sufferers develop asthma after the hay fever has lasted about two weeks.

The peculiar sensitiveness of susceptible individuals to pollens and other substances manifests itself not only in the mucous membranes of the eyes, nose and mouth but also, under certain circumstances, in the skin. It has been found possible by means of *skin tests* to determine which particular pollen or other substance is responsible for the attacks. Physicians can now obtain purified extracts of all the common pollens and other substances which produce hay fever. A small amount of such extract is dissolved in a little sterile water and either injected *into* the skin or applied to a small scarified area of the skin. Six to eight tests can be made at one time. There will be no reaction to substances to which the individual is not hypersensitive. To those for which such sensitiveness is present, a prompt *positive reaction* consisting of a red, itching wheal (like a mosquito bite) will appear in five to fifteen minutes. The reaction subsides within a few hours.

The knowledge which these tests furnish is of help in two ways. First, it may enable the sensitive individual to change his abode so as to avoid the particular pollen which causes his attacks. Second, it enables specific treatment to be undertaken with extracts of the offending pollen.

So far as the first of these methods of dealing with hay fever is concerned, it may be said that there is no particular locality in which the patient suffering from the spring or summer type of hay fever may be assured of complete relief except upon the ocean. Patients suffering from the autumnal type may avoid the attacks in the White Mountains, on the coast of Maine, in Florida, California and Europe.

In carrying out specific treatment with pollen extracts it is important to remember that over 50 per cent of the sufferers are hypersensitive to more than one pollen or other substance. As a matter of fact, about one third of the patients who suffer from the summer type are sensitive also to the pollen of ragweed, so that their discomfort lasts throughout summer and fall. It has been found that a course of spaced injections of pollen extracts in appropriate doses, if given *before* the usual beginning of the attacks, often protects the individual. As a rule, the course of treatment must be continued from year to year, so that nothing like a permanent cure is assured.

Perennial Hay Fever (*Vasomotor Rhinitis*).—In contrast to the seasonal hay fever just discussed, a similar clinical condition is often encountered in which the attacks may be continuous or paroxysmal throughout the year. In this the offending substance is not a pollen, but one of a large number of such varied substances as the dander of horses, cats, rabbits, goats, cows, guinea-pigs, chickens, geese, ducks; vegetable powders, such as orris, rice, corn, wheat, seed of cotton, kapok, flax, dust of hay and straw (not pollen); house dust; foods such as milk, eggs, fish, shellfish, nuts, chocolate, coffee, buckwheat, celery, beans; drugs such as quinine, aspirin, ipecac, senna, iodine, morphine.

When the offending substances enter the body through the alimentary tract, the symptoms are chiefly referable to the skin and consist most often of urticarial rashes (hives). Familiar types of this condition are the so-called "strawberry rashes."

The principles regarding the prevention and treatment of symptoms due to this form of hypersensitiveness are the same as those discussed above. The sensitive individual should avoid contact, as far as possible, with the offending substances. This may require a change of occupation or of residence, and also attention to diet. Specific treatment is irksome, for immunization is more or less temporary and must be continued for a long time.

Control Measures.—As far as community action is concerned, every effort should be made to reduce the amount of pollen spread by weeds. A number of municipalities have adopted ordinances dealing with this phase of the problem,

Savannah being the pioneer. In 1900 that city adopted an ordinance providing for the removal of weeds and other rank vegetable growth. In New York City the following section of the Sanitary Code was adopted in 1915:

Sec. 221. **Growth of Poison Ivy and Ragweed Prohibited.**—No person owning, occupying, or having charge of any lot or premises in the City of New York shall cause, suffer, or allow poison ivy, ragweed, or other poisonous weed to grow therein or thereon in such manner that any part of such ivy, ragweed, or other poisonous weed shall extend upon, overhang, or border upon any public place, or allow the seed, pollen, or other poisonous articles or emanations therefrom to be carried through the air into any public place.

A number of cities fix definite dates by which time property owners must cut weeds on the premises, failing which, the work is done by the municipality and the cost of the work charged as a lien on the property.

In many cities special hay fever clinics have been established, to which sufferers may be referred for diagnostic tests and specific treatment.

CHAPTER XXX

ACCIDENTS

Accidents of one kind or another still constitute a common cause of disability and death, despite the fact that many of them are distinctly and readily preventable. In 1938 nearly 94,000 deaths were charged to accidents in the United States. Among the chief causes of death due to accidents in the United States the following may be mentioned:

Automobile accidents.
Accidental drowning.
Accidental burns.
Falls.
Gas poisoning.
Railroad accidents.
Injuries by machines.
Injuries in mines and quarries.

Automobile Accidents.—Automobiles are responsible for over 30,000 deaths annually in the United States. In 60 per cent of these deaths the victims are pedestrians, mostly children. The occupants of the automobile are fatally injured only half as frequently as the pedestrians. Statistics show that three times as many boys as girls are killed by automobiles, and that, of the children, most of the victims are between five and ten years of age.

Despite the more general introduction of traffic regulation in all parts of the United States, deaths due to automobile accidents grow in frequency from year to year, and now constitute a danger to life which in many cities is several times that due to all the common contagious diseases combined. The only encouraging fact which an analysis of automobile accident fatalities discloses is the gradual decrease in the number of deaths compared to the number of automobiles registered. This indicates that much good has resulted from the more general enforcement of traffic regulations and the

establishment of safe crossings through the use of signal lights.

From the table showing the death rate from automobile accidents in the ten largest cities in the United States, the conclusion seems justified that some cities deal with this problem much better than do others. We may take a little comfort out of the fact that nine of the ten cities show a definite improvement during the past five years.

MORTALITY FROM AUTOMOBILE ACCIDENTS, TEN LARGE U. S. CITIES
(Rates per 100,000 population)

	1935	1936	1937	1938	1939
New York	14.8	12.7	13.2	12.1	12.0
Chicago	23.3	22.5	24.3	20.0	21.6
Philadelphia	15.9	15.0	16.6	16.6	17.3
Detroit	21.9	24.4	22.3	14.5	15.1
Los Angeles	42.6	42.7	43.4	37.6	?
Cleveland	26.8	27.6	30.1	19.1	16.9
Baltimore	24.2	21.8	27.7	15.8	18.7
St. Louis	23.5	19.8	22.5	13.7	13.5
Boston	20.2	19.6	18.6	14.0	11.9
Pittsburgh	23.6	23.3	26.4	18.9	11.6

Distributing the deaths from motor vehicle accidents according to the day of the week of occurrence, it is found that Saturdays and Sundays have the largest number of deaths. This is well shown in the following analysis of the 32,582 fatal motor vehicle accidents in the United States in 1938.

	Deaths.
Monday	3781
Tuesday	3321
Wednesday	3498
Thursday	3602
Friday	4009
Saturday	6294
Sunday	6203
Unknown	1874

To what extent the high week-end accident rate is due to congested traffic or to so-called "Sunday drivers" is hard to determine.

Preventive measures must be directed largely to protecting

pedestrians and particularly children playing in the streets. This means the provision of more safe playgrounds, the closing of a large number of streets to automobile traffic and the further development of traffic control. Something can also be accomplished by explaining to children the danger of streets as playgrounds and giving them definite instructions as to how to cross the street safely.

Accidental Drowning.—This accident is responsible for about 8000 deaths annually in the United States, 90 per cent of these occurring in connection with sports and recreation. Males outnumber females in the ratio of three to one. The causes of accidental drowning are too well understood to require further discussion. Preventive measures must consist in competent supervision at bathing beaches, the provision of life lines, life saving personnel and apparatus and more general instruction in swimming and in methods of resuscitating those who have been submerged. In connection with the latter, emphasis must be placed on the necessity for keeping up artificial respiration for a long time. In some countries all school children are taught swimming and it would be well for the United States to emulate this plan.

Saving Life from Drowning.—No elaborate equipment is needed to save a life from drowning; all that is necessary is to know the "Prone Pressure Method" of artificial respiration here described, and act immediately. This method is simple to learn, easy to apply, and will not unduly tax the strength of the rescuer if he happens to be alone.

On removal from the water the patient is placed stomach down on a flat surface and his mouth quickly opened to remove any foreign substance which might obstruct breathing—but no unnecessary time is wasted on such preliminaries, as every moment is precious. One arm of patient is bent at the elbow, letting the head rest on this with face sidewise so that water may be dispelled from the lungs; the other arm should be stretched full length above.

Rescue measures should begin at once and continue rhythmically until natural breathing is established—*this may take four or more hours.* The procedure is as follows:

First.—Kneel, and straddle the patient below the hips,

placing hands on small of the back with fingers over the lowest ribs, tips of fingers just out of sight (Fig. 70).

SECOND.—With arms straight, while counting *one, two,* swing forward, bearing weight on body firmly but not violently (Fig. 71).

THIRD.—Swing backward while counting *one,* straightening up and thus relieving pressure—this allows air to be drawn into the lungs (Fig. 72).

FOURTH.—Rest in this position for two counts (seconds).

FIFTH.—Repeat these movements rhythmically, forward and backward, without interruption, about twelve to fifteen a minute, until natural breathing is restored.

SIXTH.—Meanwhile, if assistance is at hand, a physician should be sent for, the patient's tight clothing should be loosened at neck, chest or waist, and the patient should be kept warm.

The patient should not be moved from this spot until he is breathing normally, and then should be carried in a lying position to a place where he can be kept warm and receive expert medical attention.

Accidental Burns and Scalds.—About one fifth of all the deaths due to accidents in the home are chargeable to accidental burns. Altogether more than 7000 lives are lost annually in the United States from this one cause, by far the greater number of victims being children. Often the accident occurs while the child has been left alone for only a short time. Many burns and scalds occur in overcrowded kitchens used as living rooms. Lighted candles or defective electric wiring on Christmas trees are sometimes to blame. Young women cleaning their gloves or dresses with gasoline or inflammable cleaning fluid, unmindful of the pilot flame on the kitchen gas range, are frequent victims of serious and often fatal burns. This is true also of those who smoke in bed.

Preventive measures must be principally educational. Parents should be put on guard against the commoner forms of this kind of danger and should teach their children to avoid fires. Fourth of July should be celebrated without firecrackers, sky rockets, Roman candles or other fireworks.

Falls.—Ordinary falls are an everyday occurrence and demand little attention as health menaces. Fatal falls, on the

Fig. 70.—Prone pressure method of artificial respiration, Step I.

Fig. 71.—Prone pressure method of artificial respiration, Step II.

Fig. 72.—Prone pressure method of artificial respiration, Step III.

contrary, are very important, for they constitute about 40 per cent of the fatal home accidents and also a large proportion of the industrial accidents. In 1938 deaths from falls numbered over 30,000 in the United States. In most fatal cases the accident is a fall from a height, as, for example, a child falling from a window, or a workman falling down a shaft. The kind of preventive measure to be employed will be governed by the nature of the particular hazard. For example, when cleaning windows in high buildings safety straps should be used. To prevent falls down elevator shafts, doors should be provided which cannot be opened once the elevator has passed beyond the floor. In dwellings attention must be paid to safeguarding the windows for young children.

Gas Poisoning.—Poisoning with illuminating gas is a frequent cause of accidental death and constitutes one of the more common forms of fatal accidents in the home. As a rule these accidents are traceable to defective tubing used to connect gas radiators and small gas stoves. Occasionally they are caused by the blowing out of a small flame by a gust of wind. In New York City in 1924 over 500 accidental deaths were due to illuminating gas, in 1925 over 600, and in 1926 the unprecedented number of 788 deaths was recorded. To meet this situation the Board of Health enacted a law which requires that all tubing be gas-tight and show no leakage under certain prescribed conditions. In 1938 there were 157 such deaths and in 1939 there were 171.

In recent years another form of gas poisoning has become increasingly prevalent, namely, that due to the *exhaust gas* from automobiles. This contains a large amount of carbon monoxide, the same poisonous constituent which makes the breathing of illuminating gas so dangerous. Accidental deaths from poisoning by automobile exhaust gas are more frequent in winter than in other times of the year and are usually caused by allowing the motor to run while the car is in a small garage of which the doors are closed. Under these conditions it takes only a short time for sufficient carbon monoxide to collect to cause death. The facts just stated indicate the character of preventive measures.

Railroad Accidents.—In the United States railroad accidents cause only about one fourth the number of deaths that

automobile accidents do. In 1938 the total number of persons killed in railroad accidents was 5,868, of whom only a very small proportion were passengers. In considering railroad accidents we must distinguish between those occurring among (1) railroad employees; (2) passengers of the railroad, and (3) users of the highways crossing the railroad tracks.

Railroad employees are engaged in a hazardous employment, and accidental deaths chargeable to this industry take the lead among fatal industrial accidents. The situation is greatly improved compared to what it was prior to the general introduction of the automatic coupling, but is still grave enough to demand serious attention.

Railroad companies vie with each other in safeguarding the lives of their passengers and are alert to take advantage of new discoveries which increase this safety. The total number of passengers killed in the United States is only about 100 to 200 yearly.

Many deaths still occur each year as a result of unprotected grade crossings. In and about all large centers of population, grade crossings should be abolished, for, though the cost may appear high, this is the only effective method of preventing this form of accident.

Injuries by Machines.—We come now to the typical industrial accident, namely, injuries by machinery. These constitute a class by themselves and demand specialized treatment by industrial engineers. Many of these accidents are fatal and a very large number result in maiming and crippling the victim for life. Thanks to the work of safety engineers, considerable attention is now being paid to the installation of special safety devices on all modern machines, so that, considering the enormous extension in the use of machinery, serious accidents from this cause are relatively infrequent. In this connection it is of interest to note that accidents of this kind increase in frequency as the day advances. Their occurrence can often be traced to fatigue on the part of the worker, and also to the use of intoxicants. In considering preventive measures, therefore, it is not sufficient to see to the installation of safety devices, but it is also necessary to study the hours of employment, the effect of fatigue, and other factors.

Accidents in Mines and Quarries.—Next to railroading, work in mines and quarries is one of the most hazardous of occupations. Both in mines and quarries the use of explosives often results in serious accidents. In mines there is the added danger of explosion of "fire-damp" and of cave-ins. For this reason there must be organized, drilled, and held in constant readiness a picked company of rescue workers thoroughly equipped to deal at once with any accident in the mine. Prior to the introduction of the safety lamp by Sir Humphrey Davy, accidents due to the explosion of fire-damp were of frequent occurrence and cost many lives. While by no means entirely done away with, such explosions are now relatively infrequent. In quarries a common cause of accident is the failure of a charge of dynamite to explode at the proper time and the overlooking of this fact in subsequent drilling.

The prevention of the various types of accidents in mines and quarries must be left to engineering specialists.

Aviation Accidents.—In the United States the number of deaths due to aviation has, of course, increased somewhat in recent years. Ten or twelve years ago they averaged less than 200 per annum. In 1938 there were 436 such deaths. It must, however, be remembered that the total number of miles flown has increased enormously. Planes operated by skilled pilots under regulation and with good equipment are being run more safely each year. A continuance of this good showing will be made possible by the development of planes that are mechanically safer, by the establishment of well-equipped airports and airways, and by the universal licensing of pilots and aircraft.

PART IV. COMMUNITY HYGIENE

CHAPTER XXXI

WATER SUPPLY

The importance attached by the ancients to pure drinking water has already been mentioned. Ruins of cisterns, wells and aqueducts attest the engineering skill of the Greeks and Romans. One of these old aqueducts at Segovia, Spain, is still in use. (See page 4.)

Water supplies may be taken from brooks, rivers or lakes (surface water), or from wells (ground water), or the water may be collected as rain water and stored in cisterns. In the final analysis, to be sure, all water is rain water, but it is well to keep in mind the classification just made because of the different types of health hazards associated with the different classes.

Surface Waters.—The water of brooks, rivers and lakes is derived from the rain that falls on the area drained by them. It is clear that in its course this rainwater may wash into a brook, river or lake any fecal matter or other polluting material that may be present on the surface of the ground. In the country, remote from human habitations, this source of pollution is negligible as a causative factor of water-borne disease; hence the water of brooks, rivers and lakes so situated is quite safe to drink and is, as a matter of fact, frequently used as a source of public water supplies.

As the population increases, however, the watershed becomes dotted here and there with homes that subsequently develop into villages and towns. It is rare that under these circumstances pollution of the brooks and rivers draining the region can be avoided. This pollution, moreover, is particularly dangerous because it consists largely of human excreta. This material may find its way into the drinking water either

through the discharge of drains conducting privy wastes directly into a stream used as a source of water supply, or through rainstorms washing the contents of badly constructed and poorly located outdoor privies into a nearby stream. In the first case the pollution of the stream is constant, in the latter intermittent. As a matter of fact, in a watershed on which there is any considerable population, both kinds of pollution can be found. In recent years another source of pollution of water supplies is causing considerable trouble, namely, industrial wastes. While these may not be carriers of infectious diseases like the domestic wastes just mentioned, they frequently render the polluted water unfit to drink because of its taste or odor, or because of the presence of poisonous chemicals. The Great Lakes furnish an example of both types of pollution. To these, however, must be added a third, namely, the pollution with the fecal wastes from a large number of lake steamers. Moreover, in considering the pollution of the Great Lakes with domestic wastes, one must bear in mind that this consists of the discharge, into the lakes, of large trunk sewers from many large and small cities located along the waterfront. Great though the volume of the lakes is, the amount of sewage thus discharged is a factor which constitutes a serious menace to the users of lake waters as water supplies. The danger will be better appreciated when it is remembered that the intakes of the water-supply systems must be relatively near the shore, where pollution is naturally greatest. To make matters still worse, the cities which draw their water supply from the lake almost invariably discharge their sewage into the lake, though an effort is made to discharge the sewage at one point and to locate the water intake some distance away. As a result of such condition, almost all the cities along the Great Lakes in the past suffered greatly from typhoid fever and other water-borne infections year after year, the rates being much higher than those of other cities in the United States. We shall return to the subject in discussing the purification of water supplies.

Ground Water.—When rain falls on the ground, part of the water flows into brooks and streams, to empty into rivers and lakes. A considerable part, however, passes through the superficial strata of the ground until it reaches an impervious

stratum, most commonly clay. The water thus held in the interstices of the looser, upper layers is known as "ground water." If there has been plenty of rainfall the level of the ground water is high, *i. e.*, the water is found relatively near the surface; during the dry season it is low. If the impervious layer of clay is not very deep down, the ground water will naturally be found near the surface; on the other hand, if it is deep down, the ground water too will be at a considerable depth. Instead of digging a well in order to reach this ground water, which is the usual way of obtaining water, one can drive a pipe into the ground until it reaches well into the water-laden stratum. By attaching a pump one can then raise

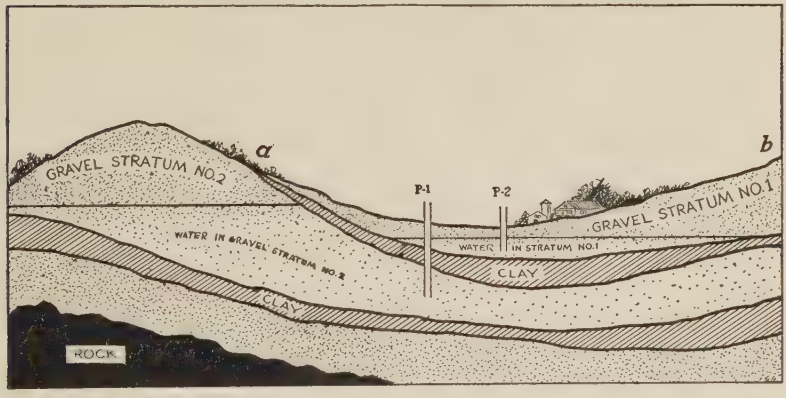


Fig. 73.—Diagrammatic representation of shallow and artesian wells.

the water by suction. From what has been said about the different depths at which the impervious layers may be situated, it will readily be seen why these pipes or wells must be driven to greater or lesser depths into the ground.

Experience has shown that one can often strike a water-bearing stratum not far below the surface, and then by driving through the impervious clay and pushing still deeper, strike another water-laden stratum. Very frequently the waters from the upper and the lower strata differ from each other in their chemical composition. How is this to be explained? Let us refer to the diagram in Fig. 73.

The diagram represents a section of the strata beneath the

surface of the ground, indicated as *a–b*. The diagonally ruled portions represent strata of clay which do not permit water to pass through. Rain falling on the surface between *a* and *b* seeps through the upper layers of soil until the water reaches the first stratum of clay, whereupon it collects and forms the uppermost layer of ground water. A pump such as P_2 will bring this water to the surface. A second pump, however, P_1, whose pipe pierces the first layer of clay, strikes a different layer of water in the stratum marked 2. This water represents rain which has fallen on the outcropping of stratum 2, an outcropping which may be many miles away from the watershed *a–b*. Inasmuch as the sand and gravel in stratum 2 may be of an entirely different mineral character from that in stratum 1, the water in passing through this stratum to reach the intake of pump 1 will dissolve out mineral constituents differing considerably from those dissolved out by the upper layer of water. If circumstances are favorable, so that the outcropping lies at a considerable height above the mouth of pump or well 1, it is possible that the water in this well will spurt out, forming what is known as the "artesian well." Engineers now apply this term (or "deep well") to any well, which, as in the diagram, draws its water from a water-bearing layer beneath the first layer of ground water. Wells that draw their water from the upper, *i. e.*, the first layer of ground water, are spoken of as "shallow wells." The terms "deep well" and "shallow well" do not refer, therefore, to the depth of the well, but to the water layer which is tapped.

Experience has shown that in its passage through the ground the water becomes purified. In other words, even though it may have become polluted with fecal bacteria on the surface of the ground, these bacteria may be filtered out in its passage through the sand and gravel of the first water-bearing stratum. However, if the ground water collects quite near the surface, it may have had so little sand and gravel to pass through that the purification is only slight. In this case the water still retains much of the polluting material it picked up at and near the surface. As a matter of fact, the water from shallow wells is often found to be polluted in this way. The water from deep wells, on the other hand, is rarely found to be polluted, for usually it has had to traverse a

long distance through sand and gravel which rid it of impurities (see below).

In rural districts shallow wells are extensively used as a source of water supply. The greatest care should therefore be taken to prevent their pollution with the discharge from privies, drains or overflowing cesspools. Particular attention should be paid to closing in the top of the well in order to prevent direct pollution from filth clinging to the shoes of those who draw water. The ground about the well should be raised so as to drain away from the mouth of the well and care should be taken to prevent fouling of the water with infected dirt and dust.

A *spring* is merely an outcropping of ground water and its safety should be judged in accordance with what already has been said. It is not always possible to determine the source from which a spring is fed. Experience, however, shows that frequently what is taken to be a fine spring is only the clear effluent of a nearby cesspool. The same precautions should be taken with a spring as with a shallow well. Whenever possible the spring should be enclosed and made safe against pollution, and the water should be conducted by a pipeline to a conveniently located tap.

Purification of Water Supplies.—The simplest method of purifying polluted water is *boiling*. While this is often of the greatest service in emergencies, it cannot be considered when dealing with the purification of public water supplies. The most valuable means of purifying these are dilution, storage, and sedimentation in large lakes and reservoirs. Many infectious bacteria die under the influence of such treatment either through inadequate nourishment, and the bactericidal action of sunlight, or through the destructive effects of other forms of aquatic life. In winter, freezing also serves to destroy the infectious bacteria. Experience, however, has shown that even all these methods together, namely, storage, sunlight, sedimentation and freezing, cannot be relied upon absolutely to make a highly polluted water supply safe for use.

A most effective method of purifying water consists in filtration through sand. *Sand filtration* of public water supplies was introduced by Simpson, an English sanitary engineer (1829). The construction of such a sand filter is shown

in Fig. 74. As the water passes through the layer of fine sand it leaves a slight deposit of scum and dirt behind, especially in the upper part of the layer. This is spoken of as the "Schmutz-decke" (in German, literally "dirt-cover"), and constitutes a very valuable element in the filtering process, for it effectively holds back even such tiny things as bacteria when water is passed through it. Inasmuch as it usually takes

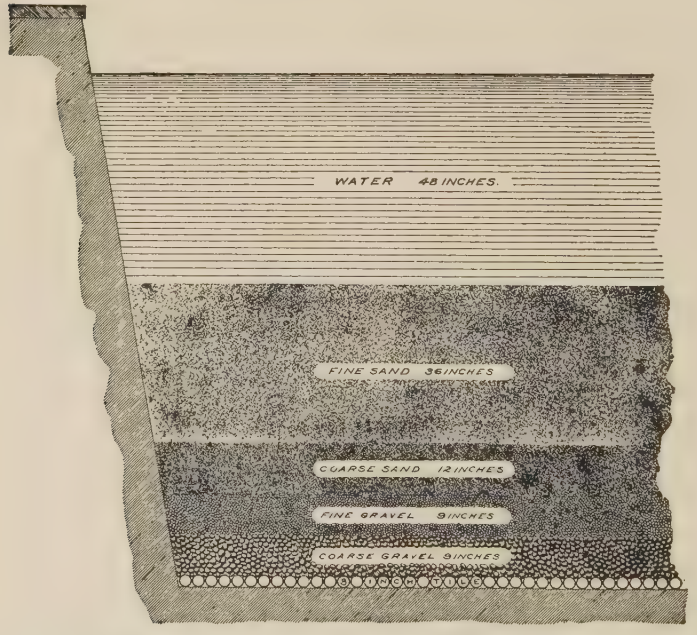


Fig. 74.—Schematic representation of a sand filter for purifying drinking water.

a few weeks for the Schmutz-decke to form, such sand filters are not as efficient when first operated as they are after several weeks of use. After a time, to be sure, the Schmutz-decke becomes so thick that the filter operates only very slowly. For this reason such filters must be cleaned from time to time by removing the upper inch or so of sand. After several such scrapings, clean, washed sand must again be added so as

not to reduce the thickness of the layer of fine sand below a safe minimum. American engineers have devised a more rapid method of filtration by first adding a little alum to the water to produce a coagulum. This acts much the same as the egg white does which the housewife adds to coffee to make it perfectly clear. After a brief sedimentation the water is then forced by pressure through a sand filter. In this process the

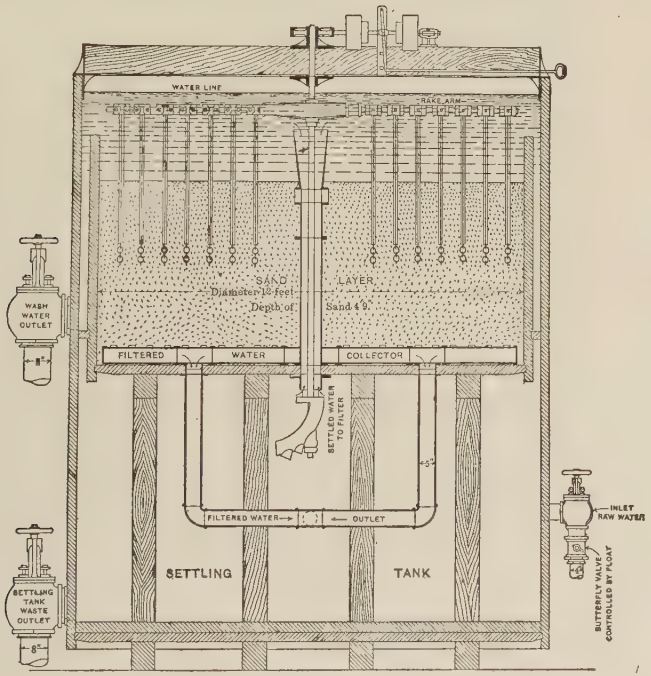


Fig. 75.—Diagrammatic representation of a so-called "mechanical filter."

coagulum plays the part of the Schmutz-decke and filtration is highly effective. After operating the filter some six to twelve hours the water is turned off, and then the sand contained in the apparatus is washed by reversing the flow, so that all the dirt and the coagulum are washed into the sewer. Then the filter is again ready for use. Wherever cities have filtered their water supplies there has been a marked reduction in

the prevalence of water-borne diseases, especially of typhoid fever. (See Fig. 40.)

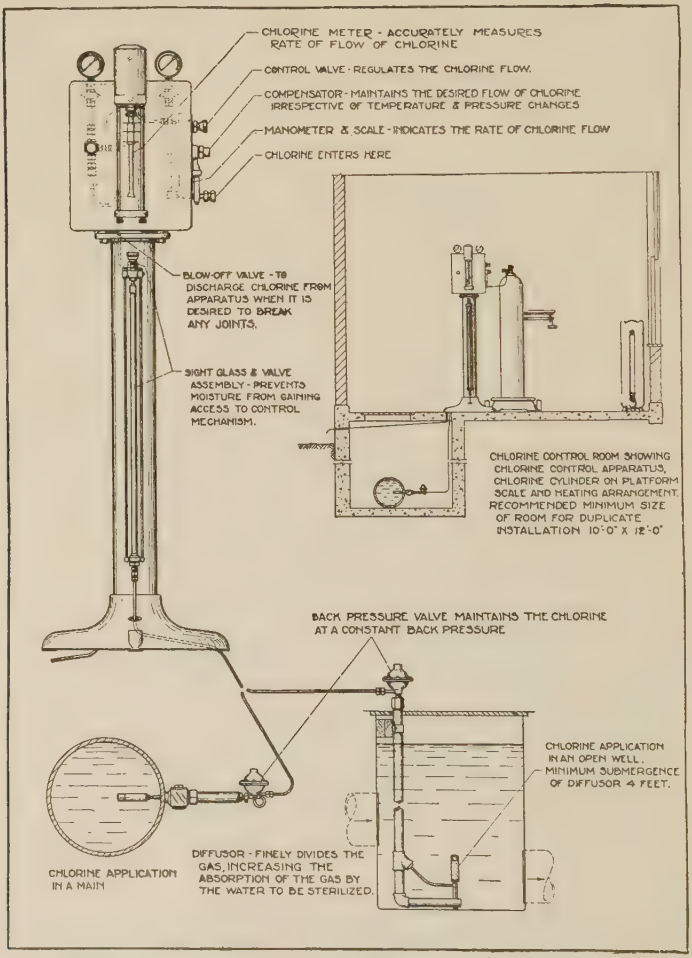

CHLORINE METER - ACCURATELY MEASURES RATE OF FLOW OF CHLORINE
CONTROL VALVE - REGULATES THE CHLORINE FLOW.
COMPENSATOR - MAINTAINS THE DESIRED FLOW OF CHLORINE IRRESPECTIVE OF TEMPERATURE & PRESSURE CHANGES
MANOMETER & SCALE - INDICATES THE RATE OF CHLORINE FLOW
CHLORINE ENTERS HERE
BLOW-OFF VALVE - TO DISCHARGE CHLORINE FROM APPARATUS WHEN IT IS DESIRED TO BREAK ANY JOINTS.
SIGHT GLASS & VALVE ASSEMBLY - PREVENTS MOISTURE FROM GAINING ACCESS TO CONTROL MECHANISM.
CHLORINE CONTROL ROOM SHOWING CHLORINE CONTROL APPARATUS, CHLORINE CYLINDER ON PLATFORM SCALE AND HEATING ARRANGEMENT. RECOMMENDED MINIMUM SIZE OF ROOM FOR DUPLICATE INSTALLATION 10'-0" X 12'-0"
BACK PRESSURE VALVE MAINTAINS THE CHLORINE AT A CONSTANT BACK PRESSURE
CHLORINE APPLICATION IN AN OPEN WELL. MINIMUM SUBMERGENCE OF DIFFUSOR 4 FEET.
CHLORINE APPLICATION IN A MAIN
DIFFUSOR - FINELY DIVIDES THE GAS, INCREASING THE ABSORPTION OF THE GAS BY THE WATER TO BE STERILIZED.

Fig. 76.—A convenient apparatus for chlorinating the water supply. (Courtesy of Wallace & Tiernan.)

There is another method of purifying polluted water, namely, that of *chlorination*. Because of its simplicity and effectiveness this method has been widely adopted in the

United States. In many instances it is used in conjunction with filtration, for the turbidity of many water supplies, *e. g.,* Mississippi River water, is often highly objectionable. When chlorination was first introduced by Johnson in 1908 as a method of purifying water supplies, chlorinated lime was used, but now compressed chlorine (liquid chlorine) is preferred. This is obtainable in steel cylinders similar to those used for liquid carbon dioxide. In disinfecting water supplies, $\frac{5}{10}$ part of chlorine is added to 1,000,000 parts of water. While the water is not made sterile, the number of bacteria is greatly reduced, especially the number of bacilli of the colon-typhoid group. This method, therefore, affords a simple means of protecting communities against water-borne typhoid fever and other water-borne diseases.

Sanitary Engineering; Plumbing.—Epidemiologic investigations of typhoid fever and other water-borne diseases have repeatedly shown that pollution of the water supply resulted from "cross connections." To understand this form of "cross connection," it is well to bear in mind that community water supplies are used not only for drinking and other domestic purposes. Of equal importance is their use in extinguishing fires. For this reason engineers see to it that sufficient water is readily available to meet the sudden demands of a conflagration. This may at times present a difficult financial problem. In the past some communities have sought to solve the problem by providing for an additional water intake, for emergency use, from some nearby river or lake which was not the regular source of the community's water supply. A sudden outbreak of typhoid fever or other water-borne disease has repeatedly been the penalty for thus piping sewage-polluted water into the domestic supply. In 1907 the senior author traced a localized outbreak of typhoid fever in the village of Katonah, N. Y., to pollution of the water supply in this manner. This form of cross connection is extremely dangerous and is now forbidden by the health authorities.

There is, however, another form of "cross connection" whose importance and frequency have become increasingly apparent in recent years. In this form there is no other water supply than one delivering a safe, potable water. Here the trouble lies with outmoded or faulty plumbing fixtures in a

home, hotel or institution which at times permit the wastes from basins, bathtubs and toilets to be siphoned back into the water supply pipes. This appears to have been the cause of an extensive outbreak of amebic dysentery occurring in two large hotels in Chicago some years ago. Considerable study has been given by sanitary engineers to the proper design of safe plumbing fixtures in order to prevent siphonage of polluted wastes into the water supply, and health authorities are now thoroughly alive to the situation.

Sanitary Supervision of Water Supplies.—It is important to exercise constant supervision of public water supplies, and this must consist both of frequent sanitary inspections of the source of supply and of laboratory examinations of the water delivered to the consumer. Neither can replace the other. The laboratory examination must be chemical and bacteriologic. As indicative of possible pollution with sewage, the chemist must study the amounts and kinds of nitrogenous constituents present, as well as the presence and quantity of certain mineral compounds, such as phosphates, sulfates and chlorides. In taking samples of water for bacteriologic examination it is necessary to allow the water to run for some time from the faucet in order to flush the pipes. If an examination of lake or river water is desired, samples should be taken in sterile vessels and shipped to the laboratory in ice. At the laboratory not only are the number of bacteria per cubic centimeter determined but special tests are made for the presence of colon bacilli. The reason for the latter tests is to detect fecal pollution, for the excreta of man always contain enormous numbers of colon bacilli. In practice the laboratory does not carry out the entire laborious technic necessary to determine definitely the presence and numbers of colon bacilli. It makes what are called "presumptive tests," for these are usually sufficient in routine work. To assure comparability of results by different laboratories it is customary to follow the Standard Methods formulated by a special committee of the American Public Health Association.

A water supply in which the presumptive test frequently shows the presence of colon bacilli in $\frac{1}{10}$ cc. of water is regarded as probably polluted with sewage and not fit for drinking without previous filtration or other purification.

Thus far we have considered water only from the standpoint of its use for drinking purposes. Its use for bathing purposes is also a matter related to public health, for it has been found that communicable diseases may be spread by bathing in infected waters. For example, instances have been reported where typhoid fever was contracted by persons bathing in sewage-polluted waters. Infectious diseases of the eyes, nose, and throat have been traced to the use of infected water in swimming pools. That the number of fecal bacteria in a swimming pool increases after the pool has been used by a number of bathers can be shown by bacteriologic examinations. In the past few years this subject has received considerable attention and health authorities have adopted and now enforce sanitary standards for public swimming pools. In almost all cases the use of a cleansing shower bath is insisted upon for all who wish to enter the pool. It is forbidden to expectorate or to discharge nasal secretions into the water. Some form of purification of the water is demanded, chlorination being the method commonly employed, though filtration is sometimes used. Instead of purification, frequent renewal of the water may be resorted to. Some authorities set bacteriologic standards for the cleanness of the water, using the total count per cubic centimeter and the number of colon bacilli as criteria. Ordinarily the former should not exceed 500 per cubic centimeter and colon bacilli should be absent in three out of five samples of 1 cc. each.

It has not yet been possible to set up satisfactory laboratory standards for the waters of bathing beaches. The pool standards just described would be unnecessarily strict.

CHAPTER XXXII

SEWAGE DISPOSAL

It has already been pointed out that the remains of elaborate systems of sewerage have been discovered by excavations of some of the ancient cities. Another common method of disposal of domestic sewage, especially excreta, is indicated in the old Hebrew injunction contained in Deuteronomy xxiii, 12 and 13:

> "Thou shalt have a place also without the camp, whither thou shalt go forth abroad:
> "And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee."

As a matter of fact, this method of disposing of excreta is now recognized as being entirely sanitary, for the upper layers of soil contain bacteria which break down offensive organic matter into harmless mineral substances. (An exception must be made in the case of excreta containing the eggs of hookworm. See page 178.)

From a sanitary standpoint, our principal interest, in connection with sewage, is in the proper disposal of excreta in order to prevent the spread of infectious diseases. We shall do well to take up separately the disposal of excreta in rural communities having only outdoor privies, and sewage disposal in communities having water-closets.

Sanitary Privies.—It is hard to exaggerate the tremendous public health importance of the movement now being carried on in various parts of this country to secure the general adoption of sanitary privies in rural districts and small towns. No other single measure has been so productive of good results, both directly in reducing the prevalence of typhoid fever, and indirectly, in raising the general standards of sanitation. Credit for initiating and persistently promoting this campaign is due to Stiles and Lumsden of the United States Public Health Service.

By the term "sanitary privy" is meant a privy with properly ventilated water-tight receptacles to catch the excreta, and so constructed that flies cannot gain access to the excreta deposited in them. The receptacles must be emptied regularly. The contents are usually disposed of by digging them under in a suitable location and in such a manner that they will not be likely to contaminate water supplies or give rise to possible hookworm infection. In smaller towns this work is usually let out on contract to a scavenger who makes regular collections and leaves an empty clean receptacle in place of

Fig. 77.—Charles Wardell Stiles, U. S. Public Health Service (1867–1941).

the one taken away. Disposal is on a suitably located field away from habitations, a furrow being run by plow, the cans being dumped into the same, after which the excreta are covered with earth.

Water-closets.—The ideal method of removing excreta, household and industrial wastes is by the water carriage system. With water supply, proper plumbing and sewerage the excreta are at once washed away into a system of closed pipes and removed promptly and completely from the vicinity of the dwelling, thereby eliminating the possibility of nuisance conditions and disease infection. The recognition of these

facts is comparatively recent and the use of the water carriage system for removal of excreta from the household is essentially a modern one, younger by centuries than the system of public water supply. The Cloaca Maxima of Rome and other so-called sewers of antiquity were drains rather than sewers, their function being to lower the ground-water level and carry off surface water. They received only liquid wastes and did not carry excreta and household wastes. Until 1815 the discharge of any wastes but kitchen slops into the drains of London was prohibited by law. Other wastes were taken care of largely by the surface gutters along the narrow streets, into which the liquids were thrown through open windows from buckets conveniently kept in the houses until they were overflowing. Householders were often not very meticulous in the separation of these wastes, and sometimes were inconsiderate of the safety and comfort of the passerby in the time chosen for discharging them into the gutter below. In Paris it was not until 1880 that excreta and solid wastes were permitted to be discharged into the sewers, and the same methods of gutter disposal were in vogue as formerly in London. It was customary, and typical of that delightful French courtesy, for the person to yell without looking "Gardez l'eau" ("Look out for the water") when a bucket of miscellaneous wastes was thrown, and expect the pedestrian to get out of the way. Almost every street presented a chorus of "Gardez l'eau's" and the spectacle of jumping, shivering, cursing Frenchmen. During certain hours of the evening, when the downpour was heaviest, umbrellas were generally carried to afford some degree of protection.

Development of Present-day Concepts.—Modern sewerage and sewage disposal really had its beginning in the epoch-making report of the Health of Towns Commission of Great Britain in 1844, which revealed the accumulation of such an astonishing amount of decomposing organic matter and filth of all kinds in the cities that it aroused British sanitarians to a strong movement for the amelioration of these conditions. Public and private cleanliness were taught and practiced as never before. Sanitary plumbing came into being, and the pail system of sewage disposal gave way to the water-carriage system. Only three years thereafter, in 1847, it was required

by law that all sewage be discharged into those drains from which it had been excluded by law in 1815. Other cities in Europe and America followed London's lead, some very slowly. We see that sanitary plumbing and sewerage are comparatively young arts—only seventy or eighty years old. And

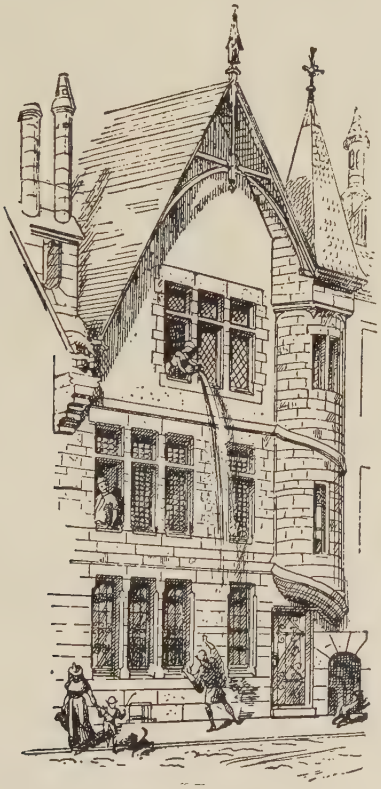


Fig. 78.—"Gardez l'eau" (see text).

it was not until years later that the hygienic aspects of sewage disposal assumed the importance that they command today. It has been but eighty years since Pasteur established the germ theory of disease, and less than that since Koch and other workers isolated and identified specific disease organ-

isms. Until that time the presence or significance of pathogenic organisms in sewage was unknown, raw sewage was discharged into brooks and rivers, public water supplies were not purified, and the great prevalence of disease was attributed largely to the effect of sewer gas. Sewage treatment devices have been in general use for only a few decades or so, but in this short time their effect has been demonstrated in the remarkable decrease in death rate from the intestinal diseases.

In communities or homes having a piped supply of running water, where, therefore, water-closets are used, the problem of a proper disposal of the wastes often presents serious diffi-

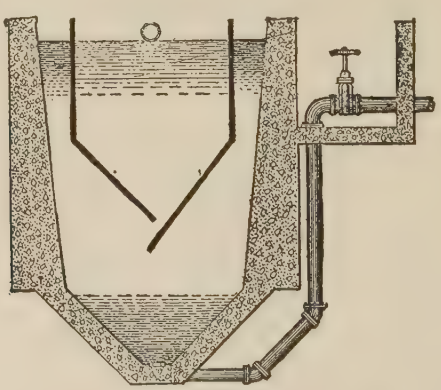


Fig. 79.—Diagram of an Imhoff tank for digesting sewage. (From Methods of Sewage Disposal, Ogden and Cleveland, Wiley & Sons, Publishers.)

culties. The simplest plan is to discharge the wastes into a *cesspool*, and for scattered homes this may constitute a safe and sanitary method of disposal, provided the soil is suitable and there is no possibility of infecting a water supply. This method is unsafe and insanitary, however, in the more built-up parts of villages and towns, for the number of cesspools to a given area then becomes more than the soil can deal with. Under these circumstances some system of sewerage must be provided. In the past many communities have considered it sufficient to construct a system of sewers into which the wastes from the individual home were discharged, the whole being

collected into a trunk sewer which conducted the sewage into some nearby river or lake. This was the common practice of a large number of American cities until recently, and frequently resulted in the pollution of public water supplies. Public health authorities have gradually forced the adoption of sanitary methods of sewage disposal. Just what forms these methods must take in any given community depends on local conditions.

Modern Sanitary Methods.—*Septic Tank.*—In dealing with the disposal of sewage from only a small group of homes, a satisfactory plan consists in conducting the sewage into a tight vault, the so-called "septic tank," in which the sewage is allowed to settle. It seems to be the popular belief that when sewage is passed through a septic tank it is purified and rendered safe for any disposition. This is far from the truth. Only a portion of the suspended organic matter has been removed, and none of the dissolved putrescible matter. It is just as dangerous as a source of infection as was the raw sewage, and is never suitable for discharge on the surface of the ground, or into a stream which is used nearby as a source of water supply or for bathing. To be rendered safe for such discharge the effluent from the tank should be subjected to treatment by subsoil irrigation, or to some other form of secondary or oxidizing treatment, which will be discussed later. From the septic tank the effluent can be carried by a siphon into a series of subsoil drains placed about 2 feet beneath the surface of the ground and covering a field whose size must be proportionate to the amount of sewage to be dealt with. Here the effluent drains into the ground. Given the proper kind of soil, and a suitable location, such a system gives excellent results and requires very little attention. The disposal field can be used as a lawn, or it can be cultivated as garden or farm land, though in the latter case it is well to limit it to such crops as grain or hay.

A special kind of septic tank for the bacterial digestion of the crude sewage is one devised by Imhoff, a German sanitary engineer. The effluent from such a tank requires the same further treatment as that of the ordinary septic tank if it is to be discharged into a stream or river used as a source of water supply.

Trickling or Sprinkling Beds.—In dealing with the sewage of larger towns and cities one must usually employ other methods of disposal. Experience has shown that one can take advantage of the bacteria contained in sewage to destroy the organic matter and render it inoffensive. A common device consists in what is known as "trickling" or "sprinkling beds." These consist of concrete tanks filled with coke or broken stone, over which the sewage is sprinkled and allowed to trickle through. In its course over the surface of the coke or stone the sewage deposits a scum which consists of enormous cultures of bacteria. These bacteria lay hold of the organic matter which adheres to the scum, and cause its decomposition into mineral substances, especially into nitrates and nitrites. In other words, the offensive, putrescible sewage is changed into an inoffensive, nonputrescible watery fluid. It is, to be sure, still loaded with bacteria and should not, in this stage, be discharged into a stream or river which is used for drinking water. This problem, however, can readily be met by treating the effluent from the sprinkling bed with a disinfectant such as chlorine.

Treatment by Activated Sludge.—Instead of using trickling or contact beds for effecting the oxidation of raw sewage there has recently been developed an effective method known as "treatment by activated sludge." The sludge of sewage consists of the suspended decomposing organic matter. Naturally, it teems with bacteria. If the sludge has been aerated by blowing air through it, these will consist principally of aerobic bacteria, which break down the organic matter into nitrates and nitrites. Such aerated sludge is spoken of as *"activated* sludge." In practice it is added to crude sewage in specially constructed tanks through which air is forced in order to aerate the mixture. The object of aeration is twofold: (1) to supply sufficient oxygen to support the aerobic action of bacteria; (2) to produce sufficient agitation of the tank contents to assure intimate contact of the activated sludge particles with all of the crude sewage. The time for aeration increases with the strength of the sewage and the degree of purification required. Four or five hours' aeration with 20 to 30 per cent of activated sludge added to the crude sewage usually gives good results.

In some respects the use of activated sludge can be compared to the addition of yeast to a solution of sugar in order to cause the sugar to ferment, the activated sludge playing the part of the ferment which breaks down the organic matter of the sewage into simple mineral salts. But a large part of the purifying effect appears to be merely mechanical, the fine suspended particles of organic matter present in the crude sewage being agglutinated into larger flocculi which subsequently settle readily when the mixture is allowed to stand at rest. The effluent from the tank in which the sewage has been treated by activated sludge shows a large reduction in the number of bacteria and is usually as clear as drinking water. In practice one usually disinfects such effluents by chlorination before discharging them into lakes or rivers used as sources of water supply. At regular intervals a portion of the sludge is removed from the settling basins and added to the incoming raw sewage, while another part is filtered to remove the water, and then dried in special kilns. This dried sludge, having the appearance of coffee grounds, is sold as fertilizer, and brings a return of about $25 per ton. A sewage disposal plant of this type is being operated at Milwaukee with very satisfactory results and without any nuisance whatever. Instead of drying the sludge, New York City pipes it into tank scows and disposes of it out at sea.

In some cities the effluent from sprinkler beds is led to sand filter beds where the bacteria are filtered out effectively. In other communities the sand filters are used without previous treatment of the sewage in trickling beds. Such sand filters, however, demand considerable attention, though the results are excellent.

Degree of Purification Required.—The degree to which a city's sewage must be purified depends largely on the character of the water into which the effluent is discharged. A very high degree of purification must be insisted upon if the effluent is to be discharged into a small river used as a source of water supply by other communities. On the other hand, if the effluent is discharged into a large navigable river or into a bay, all that may be required will be sufficient purification, for example, by means of trickling beds or even by screening, to prevent offensive odors or similar public nuis-

ances. To what extent sewage can be purified is well illustrated by an example observed by the writer some years ago at Pittsfield, Mass., where the foreman in charge of the sand filters which purify that city's sewage regularly drank the clear effluent from the sand filters. Tests of the effluent showed that bacteriologically it was as pure as any good drinking water. For esthetic reasons the writer declined to follow the foreman's example.

CHAPTER XXXIII

DISPOSAL OF OFFAL, GARBAGE AND RUBBISH

The disposal of offal, garbage and rubbish is not nearly as closely related to public health as is the disposal of sewage. To a large extent the former is a matter of civic housekeeping and esthetics, though some features of the work do deserve the attention of the official health agency.

In larger cities the quantity of offal which may be obtained from butcher shops and hotels makes the operation of a scavenger service commercially profitable. Taken to a disposal works the offal is cooked, and the fat removed for use in soap-making. The evaporated and dried tankage and the ground bones find a profitable market for use in fertilizers. The operation of these rendering plants often gives rise to offensive odors and other nuisances, and therefore requires careful sanitary supervision and control.

The disposal of garbage and rubbish, especially in larger municipalities, often presents difficult problems. Some communities enforce a strict separation of garbage from ashes and rubbish, and use the garbage for feeding hogs. In practice this has been found to be a prolific source of trichinous pork. Other communities have dumped the garbage on suitably remote fields and then plowed it under, a practice which soon attracts large numbers of rats and other vermin. Until recently, New York City loaded its garbage and refuse on scows which subsequently dumped their load at sea, twenty miles from shore. This proved highly objectionable, for much of this unsightly material was later washed up on the nearer bathing beaches. Disposal by incineration is coming to be used by many cities, and would seem to be the ideal method. It is, however, expensive, and the operation of the incinerators may readily give rise to offensive odors unless constant expert care is given.

Under Mr. William F. Carey, Commissioner of Sanitation, New York City has recently returned to the logical plan of using garbage, rubbish, ashes and other wastes *for reclaiming waste lowlands*, especially marsh lands. The important

feature of Commissioner Carey's method is the immediate coverage of the fill with a substantial layer of earth, the whole being pressed down by heavy steam rollers.

The material thus used for land fill is mixed refuse, containing ashes, glass, wood, metal, paper, garbage, leaves, and miscellaneous refuse. It is the presence of garbage which usually leads to public protests on the part of nearby residents to this form of disposal. Actually, garbage makes up only a very small proportion of the total. Thus, a study conducted by the Sanitary Engineering Department of New York University* showed that in New York City, food refuse made up a little over 6 per cent of the total rubbish. Furthermore four-fifths of this was vegetable and fruit waste. It is significant that those residents who originally opposed these land fill operations are now hearty supporters of the method, for there have been none of the evils which they feared, and the appearance of their neighborhood has been vastly improved.

The New York University survey showed that the "organic fraction" (food refuse, paper, wood and miscellaneous) made up 29 per cent by weight and 60 per cent by volume of the total refuse. This organic material will gradually decompose and the fill will settle. However, because of the packing down by the heavy steam rollers at the time of fill, this further settlement is slight. New York City's experience indicates that this method of disposing of mixed rubbish has many advantages and, when properly carried out, is sanitary and inoffensive.

This method of disposal does not require, on the part of the householder, a separation of garbage, rubbish and ashes, or on the part of the municipality separate collection services. From an administrative standpoint these are great advantages. The method, moreover, is constructive, especially when contrasted to incineration, for it reclaims unsightly areas which impede the development of the municipality. Depending on the location it can, within a relatively short time, convert unsightly and offensive submarginal areas into attractive public parks. Indeed, after a period of year, it can even create areas suitable for building purposes, and so add taxable property to the assessment rolls.

* "Some Notes on Sanitary Land Fills," L. V. Carpenter and L. R. Setter, Amer. Jour. Public Health, Vol. 30, No. 4, April, 1940.

CHAPTER XXXIV

ADMINISTRATIVE CONTROL OF THE MILK SUPPLY

Because of its intimate relation to public health the administrative control of the milk supply is one of the most important functions of health authorities. Effective control is beset with difficulties. The milk consumed in towns and cities

Fig. 80.—Making poured plates of samples of milk to determine the number of bacteria.

is never fresh from the cow and is rarely delivered directly by the producer. In large cities the milk is usually brought from farms 50 to 100 miles away. Some of the milk sold in New York City comes regularly from dairies over 300 miles away. In order, therefore, to safeguard such supplies, effective supervision must be exercised on the dairy farms, at the collecting stations (creameries), on the transportation lines,

at the pasteurizing and distributing plants in the city, and in the retail stores where the milk is sold to the consumer.

Bacteria in Milk.—It is practically impossible to obtain milk absolutely free from bacteria. Even when freshly drawn from the cow, with every reasonable means taken to insure cleanliness, it will contain from 500 to 5000 bacteria per cubic centimeter. The number in any sample of milk depends on three factors: (1) the number deposited in the milk, at the time of milking, from the cow's udder, from the hands of the milker, from the air, and from the milking utensils; (2) the time which the bacteria have had to develop; (3) the temperature at which the milk has stood during this time. For the health administrator the bacteria in milk have great practical significance, despite the fact that the majority of these bacteria are saprophytes, *i. e.*, not pathogenic; from their number one can determine something as to the care taken in handling the milk.

Few, even of the well informed, appreciate how great a difference a few degrees in *temperature* will make in the rate of bacterial multiplication. Milk rapidly and sufficiently cooled keeps almost unaltered for thirty-six hours, while milk insufficiently cooled spoils rapidly. The cooling should be carried out as soon after milking as possible, so as to keep the number of bacteria down to a minimum. In hot weather it is practically impossible to do this without refrigeration. How rapidly a few hours' exposure of milk to the ordinary temperature of a hot summer's day will increase the number of bacteria in the milk can be seen from the following table summarizing an experiment carried out by Park in the laboratories of the New York City Department of Health. Three different samples of milk were examined, the milk being kept at 32° C. (90° F.):

	Milk I. Fresh and of good quality.	Milk II. Fair quality.	Milk III. Poor quality.
Original number of bacteria per cubic centimeter	5,200	92,000	2,600,000
After two hours	8,400	134,000	4,220,000
After four hours	12,400	470,000	19,000,000
After six hours	68,500	1,260,000	39,000,000
After eight hours	654,000	6,800,000	124,000,000

It is only fairly recently that the danger of the usual bacterial contamination of milk has been understood. We now know that most of the bacteria ordinarily present in milk are bacteria which gain access to the milk from the dust of the dairy barns, from soil, manure, water used for rinsing the cans, from the hay, and so on. Experience has shown that milk which contains even very large numbers of such bacteria may be safe for adults and older children, but it is apt to produce serious bowel trouble in young infants, especially in summer.

Unfortunately, milk frequently contains pathogenic bacteria in addition to the ordinary saprophytic bacteria just discussed. Thus, owing to the great prevalence of tuberculosis among cattle, raw milk often contains living bovine tubercle bacilli. Different observers have found tubercle bacilli in from 10 to 30 per cent of the samples of unheated city milk. In England, where pasteurization has made but little headway, a large number of infants and young children die of infection with bovine tubercle bacilli.

Another disease germ derived from diseased cows is the streptococcus, which commonly finds its way into the milk from a diseased udder or teat (mastitis).

Quite recently attention has been called to the transmission of Brucella abortus from cows to man, the disease in man being known as "undulant fever." (See page 98.)

Besides the pathogenic bacteria derived from diseased cows, milk occasionally contains disease germs derived from human infections. The more common disease germs of this kind are the typhoid bacillus, the streptococcus of septic sore throat, the diphtheria bacillus, and the streptococcus of scarlet fever.

Much can be done to produce a pure, safe milk by keeping stables and cows very clean, and by using due precautions when milking to keep out dust and dirt. Then the warm milk must be cooled rapidly to about 40° to 50° F., bottled in clean, sterile bottles, and shipped cool (iced in warm weather) to the consumer. Such conditions prevail at comparatively few dairies and naturally increase the cost of production considerably, bringing such milk beyond the reach of the great masses. When, therefore, for any reason the bacterial con-

tent of milk is high, it is possible to resort to sterilization by heat. The simplest plan is to heat the milk to boiling, and then to let it cool rapidly. This is the invariable practice of the housewife in Germany, where the drinking of raw milk is almost unknown. The objections to boiling are, first, the coagulation of some of the proteins, which may render them less digestible, and secondly, the peculiar taste and odor imparted to the milk, which to many is distinctly unpleasant. For these reasons in the United States pasteurization has largely come into use as a means of safeguarding the milk supply.

Pasteurization of the Milk Supply.—To destroy bacteria, the exposure of the milk for a short time to a higher temperature is equivalent to a longer exposure at a lower temperature. The ferments and other labile constituents, on the other hand, are altered much more at the higher temperatures. It is well, therefore, to choose the lowest possible temperature which will kill the nonspore-bearing pathogenic bacteria in a practicable length of time. In practice it has been found that 61.5° C. (143° F.) for thirty minutes or 70° C. (158° F.) for three minutes are about equally effective, but the former is preferable, for it does not affect the cream line of the milk.

There are two main types of commercial pasteurizers in common use. In the first the higher temperature and short exposure are employed. This is known as the "flash process." The milk to be pasteurized is allowed to run in a thin stream over a metal surface which has been heated by steam to the required temperature, or it may run through a coil of tubes which is kept in hot water, bringing the temperature of the milk up to the desired degree. It is important that all the milk be thus heated, since otherwise many bacteria remain alive in some of the milk and quickly develop throughout the whole of the milk. In the second type of commercial pasteurizer the milk is heated and then run into tanks where it is held at the required temperature for the necessary time. As a rule, 61.5° C. (143° F.) is used, with an exposure lasting thirty minutes. The second method is usually spoken of as the "holding process" and is the one insisted upon by most health authorities.

In New York City no milk may now be sold unpasteurized except that known as "certified milk." This latter constitutes less than 1 per cent of the total supply.

Development of Modern Control Methods.—Effective control of the milk supply by the health authorities dates largely from the successful measures adopted by the City of New York in 1905, based on the extensive studies carried on by Park and his co-workers at the Department of Health. The legal basis for the system is the law enacted in 1896 to prohibit the sale of milk in the city except under a permit from

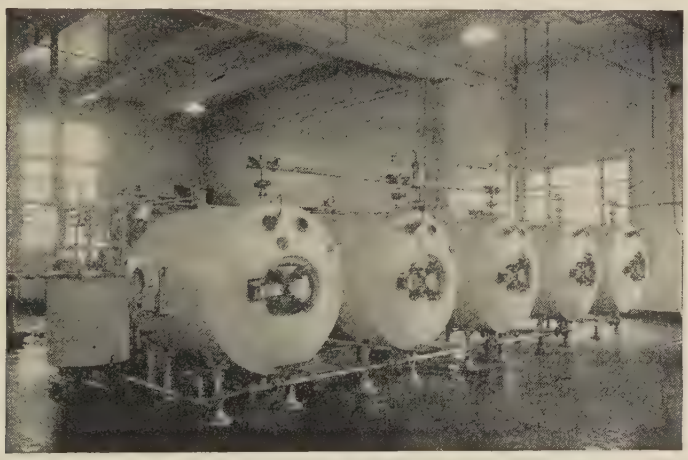


Fig. 81.—A modern milk pasteurizing plant. (Courtesy of Borden Farm Products Co.)

the Board of Health. The permit is granted subject to compliance with regulations which may from time to time be adopted by the board. Among the conditions laid down is the right of the board to prescribe sanitary standards for the dairy farms, creameries, etc., and to inform itself by inspection that these standards are maintained. This attempt of the City of New York to exercise authority over the milk production of dairies located in other states was challenged by the milk interests, and the whole case was carried through the courts in appeal after appeal until finally the Supreme Court of the United States in a unanimous opinion fully

upheld the position of the city as reasonable, valid, and not unconstitutional. The permit system inaugurated by New York City was quickly adopted by cities and states throughout the Union and now constitutes the basis for effective control of the milk supply by public health authorities.

Almost everywhere throughout the United States during the first decade of the present century the milk supply consisted largely of raw milk and of milk which had been "commercially pasteurized." The raw milk, to be sure, was of a far better quality than it had been. An extensive system of country milk inspection organized by the Department of Health maintained supervision over thousands of dairies and shipping stations supplying milk to the City of New York. Nevertheless, in spite of all inspections, serious outbreaks of milk-borne diseases occurred again and again. Moreover, bacteriologic examinations of market milk showed that a considerable proportion of the milk sold in New York contained living tubercle bacilli, derived from tuberculous cows. Such infected milk caused tuberculous infections in children.

The process of "commercial pasteurization," in which milk is exposed for only a few seconds to a *high* temperature, was useful only to the milk dealers, for it enabled them to keep stale milk from souring. As practiced at that time it was demonstrably ineffective in preventing infection with tubercle bacilli.

In 1912, therefore, impressed by the need of making the milk entirely safe, the New York City Board of Health adopted regulations which provided for the pasteurization of milk by the "holding process." This process effectively destroys all pathogenic bacteria, including tubercle bacilli.

It is only fair to say that much of the credit for the introduction of pasteurization of milk supplies belongs to Mr. Nathan Straus who for years carried on a persistent campaign pointing out the advantages of this safeguard.

Milk Grades.—In their efforts to improve the quality and safety of the milk supply, health departments established various grades of milk, setting standards for each grade. Thus, in 1910, New York recognized three grades, designated as A, B, and C. Of these only Grade A was regarded as suitable for infant feeding, and Grade C was permitted to

be sold only for cooking and manufacturing purposes. As the years went by and as the milk industry advanced, the standards were raised. In 1927 New York prohibited the sale of Grade C milk. Along with some form of grading, health departments in various parts of the United States gradually adopted compulsory pasteurization, at first only for Grade B, and subsequently also for Grade A milk.

Approved Milk.—New York City has recently (1940) abolished the grading system and now permits the sale of only one kind of milk, designated as "approved milk," setting standards for this that ensure its entire safety, even for infant feeding. The sale of a richer milk with a distinctly higher butter-fat content is allowed, but the Health Department prohibits the producers and dealers making any claims that this is a safer or more wholesome product than "approved milk."

Certified Milk.—In almost all American communities the health authorities permit the sale of unpasteurized milk produced under the strict control of medical milk commissions, and sold as "certified milk." The cost of producing this milk is so high that it nowhere constitutes more than a very small proportion of the total milk supply.

As at present organized, the administrative control of milk supplies embraces the enforcement of sanitary standards, including both equipment and methods on the dairy farms, in the creameries and shipping stations, in the methods of transportation to and in the city, in the pasteurization plants in the country or in the city, and finally in the retail stores where the milk is sold to the consumer. Naturally, in addition to this, effective control is exercised to ensure that the milk is not watered, or treated with preservatives or other adulterants. On the whole, nowhere else in the world is the general standard of market milk so high as at the present in the United States. The enormous improvement effected in the past twenty years is reflected in the striking reduction of infant mortality and in the infrequency of milk-borne infectious diseases.

The Phosphatase Test.—The administrative control of pasteurization has been markedly strengthened by the introduction of the "phosphatase test," whereby it can be deter-

mined whether or not milk has been properly pasteurized. This test, devised by Kay and Graham in England, is based on the detection of phosphatase, an enzyme supplied by the mammary glands of the cow and constantly present in raw milk. The enzyme is destroyed by correct pasteurization,* but is present and detectable when the pasteurization has been inefficient, or has perhaps even been omitted.

Adopting the underlying principle of the Kay-Graham method, Scharer, chemist in the New York City Department of Health, in 1937 devised another method of detecting the presence of phosphatase. Experience has shown this to be delicate, accurate and rapid, so that the test can be made by a field inspector during plant operation. It will detect the addition of as little as $\frac{1}{10}$ per cent of raw milk, or a deficiency in pasteurization temperature of 1° F., or a few minutes' deficiency in the holding process.

Dried Milk.—The use of dried milk is rapidly increasing, for experience has shown that this form of milk can often be used to advantage, *e. g.*, when traveling. Dried milk is prepared chiefly by two processes. In one the milk is dried while in the form of spray; in the other it dries as a film on hot rollers. In the former process the albumins remain practically soluble. Park states that "when prepared from milk of good quality, dried milk has about the same value as pasteurized milk." The vitamins are partly destroyed by heating, and partly by long storing. It has been found that dried milk can be irradiated by ultraviolet rays from a quartz mercury vapor lamp so that it acquires a high degree of antirachitic power.

Canned Evaporated Milk.—The term "evaporated milk" is applied to whole milk which has been evaporated in suitable vacuum pans to half its original volume. It contains no added sugar. As sold in sealed cans it is practically sterile, and it is therefore well adapted for domestic use, especially for infant feeding and for cooking. Much of the evaporated milk now on the market is reinforced with vitamin D.

* The enzyme being less readily destroyed than most pathogenic bacteria, a product showing no enzyme activity by the test may be presumed to be free of pathogens originally present in the raw milk.

CHAPTER XXXV

FOOD INSPECTION

Supervision of the character and quality of food supplies and the conditions under which foods are produced, handled and sold is a public health function. The word "food," as used in this chapter, includes not only all the ordinary foods, drinks and confectionery, but also spices, flavorings and other similar substances.

In considering the conditions which may affect the wholesomeness of food we may conveniently take up in order: (1) meat inspection; (2) adulteration; (3) methods of preserving food; (4) health of persons who prepare and handle food; and (5) sanitary condition of food establishments.

Meat Inspection.—The inspection of meat at slaughter houses by trained inspectors is a necessary measure for the protection of the public health. The departments of health of the larger cities require that animals to be used as food shall be slaughtered only at licensed slaughter houses in the presence of trained inspectors. Many of the large slaughter houses in the United States are under supervision by inspectors of the Bureau of Animal Industry of the United States Department of Agriculture. An inspection is made of the living animals and also of their carcasses and internal organs. Living animals are condemned when they are evidently diseased or show signs of sickness. When a slaughtered animal shows signs of disease its carcass and internal organs are laid aside and examined in detail later. If the disease is localized, the affected parts are removed and placed with the offal; the remainder of the carcass is usually allowed to be sold. If the disease is generalized, the entire carcass is condemned. All meat passed by the inspector is marked with a stamp to the effect that it has been "Inspected and Passed."

Adulteration.—In considering adulteration we may confine our attention to the Federal Food, Drug and Cosmetic Act of June 23, 1939. This superseded the original Pure Food

and Drugs Act of 1906. Enforcement of the latter rested with the Food and Drug Division of the U. S. Department of Agriculture; the present Act is enforced by the same division, but this, now called the Food and Drug Administration, has been transferred to the Federal Security Agency. The Federal Food, Drug and Cosmetic Act deals only with interstate and international commerce, but inasmuch as nearly all the states have adopted practically the same law, it exercises an effective control throughout the country.

As defined by this Act, food shall be deemed adulterated:

1. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

2. If any substance has been substituted wholly or in part for the article.

3. If any valuable constituent of the article has been wholly or in part abstracted.

4. If it be mixed, colored, coated, powdered or stained in a manner whereby damage or inferiority is concealed.

5. If it contains any poisonous or added deleterious ingredients which may render such article injurious to health.

6. If it consists in whole or in part of a filthy, decomposed or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter.

(The health authorities of New York City have added to this list a provision which aids greatly in the administrative control of the milk supply. This classes milk as adulterated when it "contains an excessive number of bacteria.")

In the case of confectionery an article shall be deemed adulterated if it contains terra alba, barytes, talc, chrome yellow or other mineral substances, or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any narcotic drug.

But the Act goes still further in its efforts to protect the consumer. An important section of the law deals with misbranding, which the government very properly considers a form of food adulteration. This section provides that an article of food shall be deemed misbranded:

1. If it be an imitation of or offered for sale under the distinctive name of another article.

2. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package.

3. If in package form, the quantity of the contents be not plainly and conspicuously marked on the outside of the package in terms of weight, measure or numerical count.

4. If the package containing it or its label shall bear any statement, design or device regarding the ingredients or the substances contained therein, which statement, design or device shall be false or misleading in any particular.

The passage of the first Pure Food and Drugs Act in 1906 was achieved only in the face of determined opposition on the part of the food industry. Experience, however, has shown that its enforcement has done a great deal of good and has placed the American food industry in the very first rank in the world. At the present time actual, harmful food adulteration is seldom found, though constant vigilance is necessary to prevent a return to former conditions. Deceitful labeling of low-grade foods is still frequently discovered.

Preserving Foods.—The preservation of food has been practiced from times immemorial, the methods employed including drying in the air and sun, smoking, freezing, and the use of chemical substances, either naturally present in the foods, such as the essential oils in spices, or selected for the purpose, such as salt and vinegar. In more recent times these methods have been extended; the number of chemical preservatives has been greatly increased, and heating and cold-storage have come to play a prominent part.

The *chemical preservatives* may be divided into three groups, as follows:

1. Preservatives that are considered to be harmless to the consumer. This group includes cane sugar, salt, vinegar, alcohol, benzoic acid and sodium benzoate in minimal quantities, volatile matter in smoke, spices, oils and extracts.

2. Preservatives that are known or considered to be injurious to the consumer. This group includes formaldehyde,

salicylic acid and its salts, boric acid and its salts, fluorides, pyroligneous acid (liquid smoke), formic acid and formates.

3. Preservatives whose action on the consumer is still in doubt. This group includes nitrates (saltpeter) in pickling fluids, peroxides, sulfur dioxide, sulfites and sulfurous acid.

Preservation of foods by *heating* is one of the safest and most important methods, and is applicable to a large variety of foods, such as meats, milk, fish, poultry, vegetables and fruits. In canning, the food material is placed in the cans, then a vacuum is created, the cans are sealed and the temperature is raised to the thermal death point of the bacteria peculiar to the material being canned. In the case of condensed milk, preservation is aided by the addition of cane sugar; the same is true of jams, jellies and marmalades.

Cold storage and *artificial refrigeration* are extensively used in the preservation of meat and, in more recent years, also in the preservation of a large variety of other foods, such as eggs, butter, poultry and fruits. The term "refrigeration" is applied only to storage at freezing temperatures. The term "cold storage" is more inclusive and is applied to storage at temperatures from several degrees below freezing to several degrees above freezing. Experience has shown that foods are well preserved by cold if kept at the lowest temperature that will not destroy the tissue cells. When foods that have been properly preserved in cold storage are removed for sale, they are in the same state that they were in when put into storage. Food about to decompose will quickly decay after it is removed from the warehouse, and food that is infected will probably remain infected. But food which is fresh and of good quality when it is put into cold storage will remain so while it is in storage and will keep fresh and wholesome for a reasonable length of time after it is removed.

Many states have laws governing cold storage. These control the quality of the foods to be held, the length of time in storage, the prevention of re-storing certain kinds of foods when once taken out of cold storage, and other conditions aimed to protect the consumer.

Health and Food Handlers.—To guard against the transmission of infectious diseases through food handlers, a system of annual medical examination of such handlers and the

issuance of Food Handler's Cards was inaugurated by the New York City Department of Health in 1915. After twenty years' experience the plan was abandoned as ineffective. Experienced health administrators believe that constant and stringent supervision to ensure the cleanly handling of foods, and the proper cleansing and sterilization of eating and drinking utensils is far more important than insistence on an annual medical examination of all food handlers.

Sanitary Conditions in Food Handling.—Sanitation is an important item in establishments preparing or handling foods. Scrupulous cleanliness must be insisted upon. There should be adequate light and ventilation. The use of cellars and basements should be prohibited, except for storage. An ample supply of hot water should be provided. Toilets should be properly located and facilities for washing and drying the hands should be close by. Food should be kept properly covered and protected against flies, roaches, mice, rats and other vermin. In warm weather, food likely to spoil should be kept in clean refrigerators. The floors should be watertight and should be kept clean by sweeping and scrubbing. Dry sweeping should not be permitted. In restaurants, all dishes, knives, forks and spoons should be sterilized. At soda fountains, glasses should be sterilized or paper cups should be used. All employees in food handling establishments should wear washable gowns, and should constantly be supervised to ensure their observance of sanitary requirements.

General Administrative Measures.—Health authorities can exercise effective control of food production and distribution by securing the enactment of legislation providing:

1. That no food handling establishment be operated except under a permit from the health authorities and subject to their regulations.

2. That the provisions of the Federal Food, Drug and Cosmetic Act be adopted as part of the local sanitary code.

With such legislation to give the necessary authority, the health department needs only a sufficient budget appropriation for the necessary inspectors, chemists and bacteriologists to carry into effect the control measures which have been described.

CHAPTER XXXVI

SUNLIGHT AND ILLUMINATION

Visible light rays are not the only rays which reach the earth from the sun. This can readily be demonstrated by passing a beam of sunlight through a prism and forming the familiar spectrum. Beyond the red portion of the spectrum, where no light of any kind can be seen, a thermometer will disclose the presence of heat rays; these are spoken of as "infra-red" rays. At the other end, beyond the deep violet portion of the spectrum, rays can be discovered which, though invisible, act upon photographic plates, kill bacteria, and accelerate chemical reactions; these are spoken of as "ultraviolet" rays. Their great importance was first pointed out by Finsen. It may be well to emphasize the fact that the ultraviolet rays are invisible, for at the present time advantage is being taken of popular ignorance by foisting on the public all manner of worthless electric appliances fitted with purple-colored electric lights with the assurance that these machines produce ultraviolet rays. Besides that, it is well to bear in mind that the ultraviolet rays, valuable though they are when properly used, are not free from danger.

In passing through the earth's atmosphere about two thirds of the ultraviolet rays are lost. For this reason the chemical action of the sun's rays is greater in the tropics (where they pass through the air vertically) than in the temperate or arctic zones. It is also greater in the clear atmosphere on the tops of mountains than in the valleys and lowlands. Physicians generally are beginning to make greater use of the therapeutic action of the sun's rays. In rickets, especially, they now expose infants to the direct rays of the sun, and the results are highly gratifying. Inasmuch as the ultraviolet rays do not penetrate glass, it is important that this form of treatment be carried out in the open.

In the tropics the sun's rays are so powerful that they may cause serious injury to those who are not accustomed to

them. Whether this is due to the intense light or to the action of the ultraviolet rays is not definitely known. Tanning of the skin is undoubtedly a defensive reaction on the part of the body. Excessive exposure to sunlight may produce the conditions known as "heat exhaustion" and "heat stroke" (sunstroke), but as these are essentially *heat* effects they will be discussed elsewhere. (See page 274.)

Ultraviolet rays can be generated artificially. For example, an ordinary electric arc light gives off such rays. They are best generated in a mercury vapor quartz lamp, and such lamps have come into extensive use in the treatment of rickets, and of lupus and other chronic skin diseases. In the treatment of rickets the children are exposed directly to the rays of an arc light or a mercury vapor lamp. Experiments have shown that dried milk and oils acquire marked antirachitic properties when they are irradiated with ultraviolet rays. In the case of cold liver oil the antirachitic property can be increased by such irradiation.

Illumination.—Great advances have been made in recent years in the field of illumination, and industrial engineers have shown that improvements in illumination have had a distinct effect in increasing production and lessening industrial accidents. Improved illumination does not necessarily mean *increased* illumination, but rather the provision of efficient restful lighting free from glare. The source of the light should be placed so that the light does not fall directly into the eyes, and the illumination of the room should be such that the background is relieved from gloom. The amount of illumination should not be judged by the brightness of the lamps, but by the amount of light at the place where it is needed. This varies; thus, more light is needed for sewing on black cloth than on white. Flickering light should be avoided, for it tires the muscles that govern accommodation and leads to fatigue and pain. Reading in railway trains causes a similar strain; the eye muscles tire of trying to follow the shaking page.

CHAPTER XXXVII

AIR AND VENTILATION

The air we breathe consists of about 20 per cent oxygen, nearly 80 per cent nitrogen, 0.03 to 0.04 per cent carbon dioxide, and very small amounts of other gases. In addition to this, air always contains a variable quantity of dust and a certain amount of water vapor.

Largely as a result of the antituberculosis movement and especially because of the teachings of Trudeau in this country and Brehmer in Germany, the public has come to value fresh air as a means of fortifying the body against disease.

Until recently a great deal of misconception existed as to the difference between fresh air and "bad" air. It was well known that when a number of persons were shut in a closed room the air after a time become "stuffy" and disagreeable. Those breathing it complained of headache and faintness and sometimes the results were much more serious.

This is well illustrated by the awful tragedy in the "Black Hole of Calcutta," which Professor Lee of Columbia University so well described in the following paragraph:

"On one of the hottest of the hot nights of British India, in 1756, Siraj-Uddaula, a youthful merciless ruler of Bengal, caused to be confined within a small cell in Fort William, 146 Englishmen, whom he had that day captured in a siege of the city of Calcutta. The room was large enough to house comfortably but two persons. Its heavy door was bolted; its walls were pierced by two windows barred with iron, through which little air could enter. The night slowly passed away, and with the advent of morning, death had come to all but a score of the luckless company. A survivor has left an account of the horrible happenings within the dungeon, of terrible strugglings of a steaming mass of sentient human bodies for the insufficient air. Within a few minutes after entrance every man was bathed in a wet perspiration and was searching for ways of escape from the stifling heat. Clothing was soon stripped off. Breathing became difficult. There were vain onslaughts on the window; there were vain efforts to force the door; thirst became intolerable and there were ravings for the water which the guards passed in between the bars, not from feelings of mercy but only to witness in ghoulish glee the added

struggles for impossible relief. Ungovernable confusion and turmoil and riot soon reigned. Men became delirious. If any found sufficient room to fall to the floor, it was only to fall to their death, for they were trampled upon, crushed and buried beneath the fiercely desperate wave of humanity above them. The strongest sought death, some by praying for the hastening of the end; some by heaping insults upon the guards to try to induce them to shoot. But all efforts for relief were in vain, until at last bodily and mental agony were followed by stupor. The tragedy of the Black Hole of Calcutta will ever remain as the most dramatic demonstration in human history of the bondage of man to the air that surrounds him."

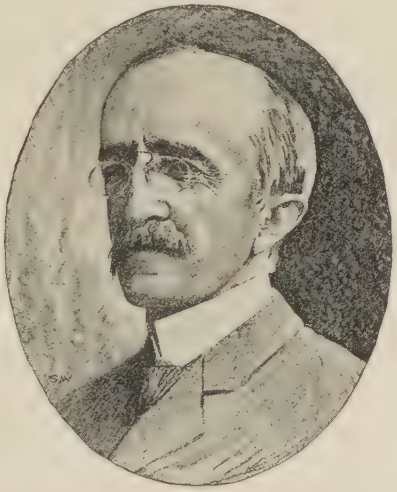


Fig. 82.—Edward Livingston Trudeau (1848–1915). American pioneer in the sanatorium treatment of tuberculosis.

Inasmuch as breathing was known to take oxygen from the air and to add carbon dioxide, the evil results of overcrowding and poor ventilation were ascribed to the accumulation of carbon dioxide. Statements to this effect can be found in many textbooks published twenty to thirty years ago. As a matter of fact, we now know that the increase of the carbon dioxide and the decrease of the oxygen are practically without significance in bringing about the symptoms observed in crowded, ill-ventilated rooms. Experiments undertaken by Flügge and his pupils about thirty years ago show this clearly. The subjects, when placed in carefully controlled closed

chambers, experienced the symptoms one is accustomed to associate with badly ventilated rooms. If they were allowed to breathe outside air through a tube, they were not relieved. If subjects outside were allowed to breathe the vitiated air from the inside, they felt no discomfort. In other words, the feeling of distress was experienced by the men in the chamber, not by the men outside, no matter which air each group was breathing.

In similar experiments the carbon dioxide has been allowed to rise as high as 3 or even 4 per cent, and the oxygen to fall as low as 16 to 17 per cent. The air has been so vitiated that a match would not remain lighted, and yet, *so long as this stale air was kept in motion and remained moderately cool,* the subjects felt no discomfort.

To fully understand this, let us examine briefly the changes that take place in the character of the air as a result of human occupation. We find that:

1. The amount of oxygen is reduced by respiration.
2. The amount of carbon dioxide is increased by the same process.
3. There is given off into the air a greater or less amount of organic material (which we perceive as more or less offensive odors), not so much from the lungs, but more especially from the mouth, the teeth, the skin and the clothing.
4. The temperature of the air is raised by the heat given off from the body.
5. The humidity of the air is increased by the moisture given off in the breath and from the skin.

We have already seen that the first two changes here enumerated have little significance in producing the symptoms due to overcrowding. The work of recent years, however, has shown that *heat* and *humidity* are important factors and that *air movement,* too, plays an important rôle.

At this point it will be necessary to say a word about thermometers, for otherwise what follows may not be clear. The ordinary house thermometer, with which all are familiar, measures merely the temperature of the air. But experience shows that the body appreciates a distinct difference between dry and moist air of the same temperature. Because in dry air the body can evaporate moisture more readily, dry air,

even though very warm, is not as uncomfortable as moist air of the same or even lower temperature.

If we inclose the bulb of a house thermometer in a little cotton bag, and then moisten this, we shall find, when we compare the reading of this thermometer with that of another uncovered thermometer hanging beside it, that the wet-bulb thermometer shows a lower reading. This is because the evaporation of the water from the moistened bag abstracts heat from its immediate surroundings and so causes more or less cooling of the bulb. When there is much moisture in the air, *i. e.*, when the humidity is high, evaporation from the bag on the wet-bulb thermometer is slow, and there is but little cooling. On the other hand, when the humidity is low, evaporation is rapid, there is considerable cooling, and there is a larger difference in the readings of the wet-bulb and the dry-bulb thermometers.

It must also be pointed out that the amount of water vapor which the air can take up depends on the temperature. Hence, humidity, as we usually employ the term, is relative. We express the *relative humidity* in percentage, meaning thereby that percentage of the total amount of moisture which the air can hold in the form of water vapor at any given temperature. Air can hold more moisture in the form of water vapor at a high than at a low temperature. If, therefore, we should find the reading on the wet-bulb thermometer the same as that on the dry-bulb instrument, we would naturally infer that the air was already saturated with water vapor, since no water could evaporate to cool the wet bulb. In other words, the humidity would be 100 per cent. In everyday life we are most comfortable with humidity ranging from 30 to 50 per cent.

In connection with investigations of conditions in mines, English experts state that exertion begins to be accompanied with depression when the wet-bulb thermometer registers 25° C. At 28° C. (wet-bulb) work can be done if clothing is removed and the maximum body surface exposed, *provided there is a current of air.* At 29½° C. (wet-bulb) only light work is possible, and at 35° C. (wet-bulb) work becomes out of the question.

Here we note that the value of the air movement is empha-

sized. This is entirely in accord with common experience, for we all know how refreshing even a slight breath of air may be on hot humid days. It is clear that the mere movement of the air cannot change either its temperature or its humidity. It does, however, remove from around the body a mass of air loaded with heat and moisture and so increases the *rapidity* with which the body can rid itself of this uncomfortable envelope. An ingenious type of thermometer has been devised to measure this effect of air movement, the so-called "Kata" thermometer, and as this is so frequently used nowadays in studies on ventilation, a brief description may be of interest.

The Kata instrument consists of two thermometers like those shown in Fig. 83. One is a dry-bulb, the other a wet-

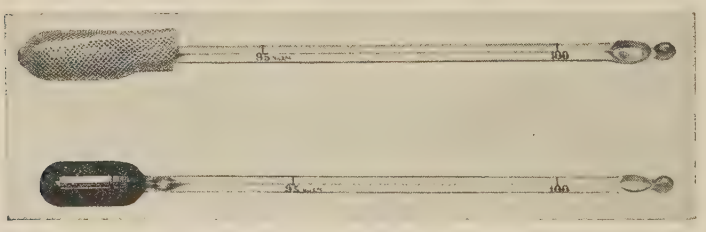


Fig. 83.—The Kata thermometer, for measuring the efficiency of ventilation, and cooling and drying processes. Invented by Prof. Leonard Hill. (Courtesy of Siebe, Gorman & Co., Ltd.)

bulb thermometer. In using the instrument, both thermometers are heated until the mercury registers about 110° C. Thereupon the bulb of the dry thermometer is quickly wiped to make sure it is really dry, and the excess moisture on the bag of the wet-bulb is stripped off. Meantime, of course, the mercury in both thermometers is dropping. With the aid of a stopwatch one then counts the number of seconds required by each thermometer for the mercury to drop from 100° to 90° C.

Experience has shown that comfortable atmospheric conditions are present when the wet-bulb thermometer drops in from forty-five to sixty seconds, and the dry, in from one hundred and fifty to one hundred and eighty seconds. In other words, a moderate degree of humidity (from 35 to 40

per cent) is desirable for comfort, but other conditions (air movement, temperature, etc.) must also be fulfilled. From scientific studies which have been made during the past ten or fifteen years it is now generally recognized that good ventilation should provide air that is cool but not cold. For ordinary sedentary life in the schoolroom or office a temperature 18° to 20° C. (65° to 68° F.) should be maintained. The air should be in gentle but not excessive motion, and its temperature should fluctuate slightly from moment to moment. It should be free from offensive body odors, from poisons, offensive fumes, and from large amounts of dust.

In dwelling houses where there is no overcrowding, these requirements can usually be met through natural ventilation, and this, after all, is by far the simplest and most effective form wherever it can be employed. In schools, factories, theaters and other large places of assembly, however, natural ventilation is often inadequate. In such cases, some form of mechanical ventilation may have to be installed. The fresh air may be forced into the room, or the bad air may be sucked out. Sometimes both devices are employed. Provisions should be made for warming the fresh air introduced in winter, or cooling it in summer. There is no one "best" system of artificial ventilation, and it is the function of the ventilating engineer to devise a system to meet the particular needs of the situation.

Air Conditioning.—Ventilation engineers have made enormous progress in recent years and are now able to cope successfully with situations that would have been deemed hopeless less than a generation ago. Witness the excellent ventilation of the Holland tunnel under the Hudson river. Despite the exhausts from thousands of motor cars, there is not the least discomfort. Or consider the modern motion picture theaters, in which the air is cool and refreshing even on hot, sultry days. Travel across the country in a modern air-conditioned train, and then think of the same trip ten or fifteen years ago.

Many of our progressive department stores attract shoppers, even when the streets are unbearably hot, by having their establishments air-conditioned.

The degree to which air conditioning can be carried out de-

pends largely on the amount of money which can be invested. From what has been said above, the air should have the proper temperature and the proper degree of humidity (moisture) and it should be in gentle motion. In areas where the atmosphere is polluted with smoke, air conditioning should also clean the air to be breathed. Ideal air-conditioning units must therefore provide for cooling the air during hot weather, and warming it during cold. The air should be filtered and washed, its moisture content controlled, and it should be so distributed that it will be in gentle motion. All these items involve expense. However, a considerable amount of comfort can also be derived from less complete, and therefore less expensive units, even though they do not provide the ideal conditions just mentioned.

This branch of engineering is still in its infancy, and it may be that before long satisfactory air-conditioning units will be as widely used as domestic mechanical refrigerators are now.

Heat Exhaustion and Heat Stroke (Sunstroke).—Persons who are exposed to high temperature, especially when there is also high humidity, may react to these by symptoms of heat exhaustion, or symptoms of heat stroke. Such conditions may arise quite independently of the direct rays of the sun. In fact, in the majority of cases the victims are industrial workers who are exposed to high temperatures within doors, as in sugar refineries, firerooms of ocean steamships, laundries and deep metal mines.

In heat exhaustion the patient's face is pale, his temperature is subnormal, the pulse extremely feeble, and the patient may be unconscious or semiconscious. Death is infrequent.

In heat stroke the patient's face is livid, his temperature is elevated (107° to 110° F. being common), the pulse is full, frequent and bounding. The victim is unconscious. Death is frequent.

Both conditions are due to disturbances of the mechanism by which the body regulates the production and dissipation of its heat. A heated atmosphere charged with moisture, impeding, therefore, evaporation, is particularly liable to bring on the conditions described. Preventive measures are those discussed under Ventilation.

CHAPTER XXXVIII

INDUSTRIAL HYGIENE AND OCCUPATIONAL DISEASES

In a previous chapter we touched upon the occurrence of accidents in industry. We shall now consider occupational hazards in general and more particularly their relation to disease. The subject of industrial hygiene and occupational diseases is one of the most important departments of preventive medicine, for it deals with the health, the welfare, and the human rights of the great mass of the people. Quoting Rosenau, "the questions of industrial hygiene strike at the very root of our social system; they include the relation of capital and labor, and the relation of man to his fellowmen. The man of means may, to a large extent, select not only the place, but even the character of his employment. He can choose his own hours of work and can largely control his environment while at work, so far as it affects his health and comfort; he can purchase fresh air, sunshine, good food, rest, recreation, and other conditions that make for health, longevity, and happiness. The employee must largely accept the conditions as he finds them, and is frequently denied many advantages, even necessities. As the power of the employee is limited, he needs the assistance of the State to correct the unreasonable demands which capital has ever exacted of labor."

In fairness to a large and increasing number of employers, however, it must be stated that many accidents and preventable diseases are brought about by the indifference, carelessness and ignorance of the employees themselves. Workmen frequently fail to take the precautions emphasized by their employers or do not make use of facilities specially installed to protect health and safety.

An occupational or industrial disease is one that would not have been contracted if the individual had not taken up his particular occupation. Many such diseases are due to poisonous and irritating gases, vapors or dust to which the

workers are exposed. Others are due to exposure to high temperatures, abnormal atmospheric pressures, and other unusual conditions peculiar to the occupation, while still others are caused by bacteria infecting the material handled in the occupation.

The list of substances that injure people at work includes acids, alkalies, lead, phosphorus, petroleum and its derivatives, tar, carbon bisulfide, aniline, benzol, chlorine, chromium, mesothorium (radium), formaldehyde, picric acid, prussic acid, carbon monoxide, dyes, printers' inks, wood alcohol, and still others. The bacillus of anthrax, the bacillus of glanders, and the larvae of hookworm may cause diseases which must under certain circumstances be classified as occupational. In the short space which can here be devoted to this subject we can consider briefly only a few of the more important occupational diseases.

Lead poisoning is one of the most common occupational diseases, and this is not surprising when one considers the many ways in which lead and its compounds are used in industry. Lead enters, for example, into the composition of most paints, into the construction of storage batteries, into type metal, into the glaze used in pottery and earthenware, into the manufacture of wall paper, and into the material used in plumbing.

In the majority of cases, lead poisoning in industry comes through the inhalation of lead-laden dust, sometimes as fumes. As a rule, a lead trade is dangerous according to its dustiness. It has been found, however, that the poison often enters the mouth through unwashed hands soiled with lead, and that careful attention to personal cleanliness in this respect can do much to lower the prevalence of lead poisoning in industries where lead is extensively used.

Lead is a cumulative poison; in fact, it is chiefly poisonous when ingested daily in small quantities. Its characteristic action is on the nerves, causing various forms of paralysis. One of the earliest signs of lead poisoning is the marked pallor of the skin, attacks of colic, constipation and muscular pains; and later, the lead line on the gums.

In preventing lead poisoning, chief emphasis is laid on measures to prevent the inhalation of lead-laden dust. Cer-

tain industrial processes should be carried on only under hoods with a strong draft to carry off the dust. Sometimes respirators must be employed. The workman must be careful to clean his hands before eating and under no circumstances should he be permitted to eat his lunch in a lead-laden, dusty atmosphere.

Phosphorus is used in making matches, although in recent years manufacturers have come more and more to use a non-poisonous sesquichloride of phosphorus. When the poisonous white phosphorus is used, constant inhalation of the fumes causes the workers to suffer from a characteristic necrosis of the jaw bone, a condition known as *phossy jaw*.

Prevention of this form of poisoning consists in prohibiting the manufacture of matches from white phosphorus. Those working in match factories should observe strict cleanliness, and should have their teeth looked after frequently by a dentist.

Carbon Monoxide.—Acute poisoning from carbon monoxide occurs as an occupational hazard in coal mines and among those working about coke ovens and blast furnaces. In recent years it has also been observed in garages, for carbon monoxide is one of the constituents of the exhaust gases from automobiles. The latter type of accident occurs most frequently in winter when the motor is allowed to run for some time in a small closed garage. There is reason to believe that the carbon monoxide discharged into the air of crowded city streets by the steadily increasing number of automobiles, may constitute a danger to public health; a number of authorities state that the prolonged inhalation of small quantities of carbon monoxide produces distinct ill effects.

Benzol is extensively used as a solvent for varnishes and for rubber. It is also used in the dyeing industry, and in the refinishing of automobiles. In the chronic form of poisoning there are changes in the blood and some enlargement of the spleen. There may be fatty degeneration of the heart, purpuric hemorrhages into the mucous membranes and skin, considerable degree of anemia, and even death.

Poisoning occurs through the inhalation of the fumes of benzol. Preventive measures must consist of ways to carry off these fumes by means of ventilating drafts and hoods.

Hydrocyanic Acid (Prussic Acid).—Poisoning by hydrocyanic acid is occasionally encountered as a fatal accident among those engaged in fumigating with this deadly gas. Such fumigations are extensively performed in ridding ships of rats, destroying meal-moths in flour mills, and caterpillars and other pests in orchards.

Woolsorters' disease (anthrax) is an infection with anthrax bacilli, whose very resistant spores cling to the hides of animals that have died of anthrax, to the wool of infected sheep, and to the hair of infected horses and other animals. The infection results in a pneumonia and general sepsis which is almost invariably fatal.

In guarding against woolsorters' disease, the hides should be thoroughly disinfected by prolonged soaking in 5 per cent cresol solution or 1:1000 bichloride of mercury. For the disinfection of horsehair, steam or boiling may be employed.

Hookworm.—"Miners' anemia," a term given to hookworm in mining districts, is now well understood. Its nature, mode of spread, and the measures for its prevention have been discussed in connection with hookworm (page 178).

Caisson disease (the "bends") is observed in those who work under compressed air—for example, divers and tunnel workers. It affects the workers during and after decompression, and is due to injuries to the central nervous system caused by too rapid passage of the worker from the compressed atmosphere to the outside air. These injuries may give rise to serious paralysis, and may even prove fatal.

The disease can be prevented by slow and gradual decompression of those working in compressed atmosphere.

Dusty Trades.—Besides the occupational diseases mentioned above, much ill health and disease are caused by the inhalation of dusts. Dust of all kinds is met with in the various industries, some of it organic, some mineral. The latter is usually far more dangerous, particularly when the particles are sharp and irritating.

Some dusts are merely mechanical irritants, others are poisonous as well. Among the former, the hard, irregular particles of iron, steel and other metals, and those from granite, basalt, quartz and marble are very irritating, while those from coal, chalk and plaster-of-Paris are less so. Wood

and paper dust, as well as flour, are but slightly irritating. Felt dust (in hat factories) and tobacco dust are highly irritating. Among the poisonous dusts, lead occupies a prominent position.

Persons exposed to excessive amounts of dust for long periods suffer from a condition known as *pneumoconiosis;* when due to coal dust the condition is called *anthracosis;* when due to stone dust, *siderosis;* when to quartz dust, *silicosis*. Sometimes the dust remains in the lungs without any reaction on the part of the tissues. Often, however, it results in the formation of connective tissue and gives rise to a chronic bronchitis. Sometimes the irritation produced by the dust is the starting point of infections with pathogenic bacteria, *e. g.*, tuberculosis.

Preventive measures must be adapted to the kind of dust and to the industry. Whenever feasible, wet-grinding should be substituted for dry-grinding. Dust in industries may be removed by suction fans or the work may be carried on under hoods having suction ventilation. Sometimes the only practicable method is to have the workmen wear respiratory masks. These, however, are so uncomfortable that many workers will not use them.

Fatigue.—This is a common cause of industrial accidents. It develops readily with monotonous mechanical operations and in poorly ventilated workrooms. Some factory managers have found it a good plan to have short rest periods regularly throughout the working day. During such a period the windows should be opened, if practicable, so as to air the workroom thoroughly. It may be feasible, also, to vary the worker's job from time to time in order to break the monotony.

Cancer.—Among chimneysweeps and others, who are in frequent close contact with soot and other similar substances, a peculiar form of cancer is often observed. It is due to the chronic irritation caused by the soot and other products of combustion.

Effects of Heat.—Besides the well-known acute effects of exposure to high degree of heat (see page 274) there is reason to believe that cataracts, retinal and choroidal changes, or chronic conjunctivitis are brought on in glassblowers and iron-puddlers by constant exposure to intense heat.

Industrial Accidents.—Supplementing what has been said about accidents in general (page 223) it may be well to enumerate some of the chief forms of *industrial* accidents:

Amputations caused by unguarded circular or bandsaws, by planing machines, papercutters, meat slicers, and the like.

Crushing injuries caused by stamping machines, mangles, presses, railroad cars, etc.

Injuries caused by moving machinery, belts, gears, etc.

Injuries due to the giving way of ropes and scaffolds, or by falling objects.

Scalding due to falls into vats containing hot liquids.

Burns and scalds from escaping steam.

Asphyxiation with poisonous gases.

Crushing by elevators.

Fires due to the careless handling of inflammable material.

Explosions of powder, dynamite, fireworks, motion picture films, chemicals.

Injuries caused by acids, caustics and other corrosives.

Preventive measures must be devised individually to meet the particular hazard to be guarded against. In general we must demand that machines be equipped with safety devices. Open vats should be protected with suitable railings and other devices. When dealing with highly inflammable material, special attention should be given to fire hazards. Smoking should be prohibited. Proper storage under adequate supervision should be provided for explosives. No form of safety device will prevent all accidents, for some workmen will always be careless. The employer, however, should endeavor to reduce them to a minimum.

Hygienic and Sanitary Shops.—The large employer of labor has learned that the provision of sanitary workshops, of hygienic conditions of labor, together with good wages and satisfactory hours of work, all help to promote efficiency and increase his output. Unsatisfactory conditions are much more common in the smaller shops, and it is these that usually require close supervision by the authorities. But even such supervision will fail to produce the desired results if the co-operation of the worker is not secured, and this co-operation can be brought about only by education.

CHAPTER XXXIX

INFANT HYGIENE. CHILDBEARING

Until within comparatively recent times the annual sacrifice in infant lives was appalling. In many crowded cities, sixty years ago, one out of every three infants born died within the first year. No wonder, therefore, that the necessity for large families was urged to keep the family tree alive. At the present time in the greater part of the United States less than one out of twenty infants dies in the first year. In practice one usually employs the term "infant death rate," meaning thereby the number of infants out of each 1000 born, dying in the first year of life. This rate is arrived at by comparing the number of deaths of infants under one year in a given year with the total number of live births occurring in the same year and by expressing this as so many deaths per 1000 live births. The following shows the infant death rate thus calculated for the city of New York in recent years:

Infant Mortality, New York City, 1900–1939 Inclusive

Annual average.	Number of births.	Deaths under one year.	Per 1000 live births.
1900–1904	126,800	15,634	123.1
1905–1909	142,600	16,671	116.9
1910–1914	140,929	14,530	103.1
1915–1919	137,781	12,505	90.8
1920–1924	131,275	9,590	73.0
1925–1929	126,786	7,919	62.4
1930–1934	110,609	5,969	53.9
1935–1939	101,092	4,288	42.4

A similar but variable reduction of the infant mortality rate has taken place in other parts of the United States, the latest available figure for the country as a whole being a rate of 51 per 1000 live births in 1938. In New York City

the rate in 1938 was 38, and in 1940 it was 35. Nevertheless, infant mortality is still a very important health problem, for the nation's rate of 51 represented the loss of 116,702 infant lives in the United States in one year. Even New York City's low rate of 35 meant 3749 infant lives lost in 1940. New Zealand, The Netherlands, Australia, Sweden, Switzerland and Iceland have regularly had lower infant mortality rates than has the United States. New Zealand, in fact, now has a rate under 30 per 1000 live births.

It will be profitable to survey briefly the steps which were taken in order to bring about the reduction in the infant mortality rates shown in the preceding table. This will enable us not only to understand more clearly what our present problems are, but also to realize why, in some countries, infant mortality rates of 100, 150, and even higher, still prevail at the present time.

HISTORICAL, NEW YORK CITY, SINCE 1875

Cholera Infantum (*Summer Diarrhea*).—Fifty and more years ago one of the chief causes of infant deaths was "summer diarrhea," also called "cholera infantum." Each year with the coming of hot weather a large number of lives were sacrificed to that disease. Moved by the appalling number of deaths summer after summer, the City of New York, in 1875, organized a special corps of physicians, called the "summer corps," whose duty it was to visit the tenements in order to discover sick babies, to treat such babies, prescribe methods of feeding, and give instruction to the mothers regarding the management of the case. The emphasis, at that time, was all on the discovery and the treatment of *sick* babies. The work was continued year after year with only moderate success.

Milk and Diarrheal Diseases.—Stimulated by the bacteriologic discoveries made during the eighties and nineties, many investigators took up the problem of cholera infantum with the hope of finding some particular causative organism of this disease. All the investigations were fruitless. In 1903 and 1904 Park and Holt carried on an extensive and well-planned study of diarrhea in infants—a clinical, bacteriologic and epidemiologic investigation. They, too, failed to discover a spe-

cific micro-organism causing such diarrhea; in fact, they demonstrated that *no one specific germ was involved*, and that infant diarrhea, often with a high case fatality, was caused by the feeding with raw milk containing enormous numbers of the ordinary dirt bacteria, *i. e.*, mostly saprophytes. The investigations furnished the first sound basis for a scientific appreciation of the part which the number of bacteria in milk play in cholera infantum and other disturb-

Fig. 84.—William Hallock Park (1863–1939).

ances of nutrition. Moreover, other studies carried on by Park about the same time threw a great deal of light on the character and source of the bacteria in milk. It was shown that the number of bacteria in freshly drawn milk was inversely proportional to the degree of cleanliness prevailing in the dairy; with cleanly conditions there were few bacteria; with dirty conditions, many. The studies also demonstrated the importance of keeping milk cool from the time of milking until it reached the ultimate consumer.

First Division of Child Hygiene.—In 1908 New York City established a Division of Child Hygiene as a definite part of the Department of Health. This was the first of its kind to be established in the world. This division took over the work of the "summer corps," but from the outset paid special attention to the education of mothers in the care of babies. The use of dipped milk bought at grocery stores was discouraged; the importance of keeping milk cold was emphasized; scrupulous cleanliness was taught and demonstrated. In contrast to the work of the summer corps, the emphasis now was

Fig. 85.—Nathan Straus (1848–1931).

placed on *keeping babies from becoming sick*. Mothers were taught how to pasteurize milk at home and how to modify it for infant feeding. In this the milk stations established by Nathan Straus, in 1898, rendered valuable assistance, for they furnished milk specially modified for babies, and delivered pasteurized, ready for feeding.

Infant Milk Stations.—In 1911 funds were obtained for the establishment of Infant Milk Stations by the Department of Health. At these stations good, safe milk for infant feeding could be purchased at a reduced price. The stations served

as educational centers where mothers could learn through demonstrations how to care for their babies. The stations were open in the morning, a physician and a nurse being in attendance. In the afternoon the nurse devoted her time to visiting the homes in the district and continuing her educational work there.

Child Health Stations.—The number of Infant Milk Stations was increased from time to time so that at present the Department of Health maintains over sixty stations in various parts of New York City. With the entire milk supply of the city pasteurized and safe for infant feeding, the stations have lost their significance as *Milk* stations; their chief purpose, at present, is to serve as educational centers. To emphasize this they are called "Child Health Stations." In addition to their primary function in connection with *infant* hygiene, their work now includes the health supervision of children of preschool age, and the education of expectant mothers regarding the importance of adequate, prenatal medical supervision. (See also page 294.)

The activities thus briefly reviewed proved highly successful in reducing the city's infant mortality. They are, in fact, essential first steps. After a time, however, it was realized that something more was needed in order to effect further reductions in infant mortality. The necessity for additional activities is discussed in the following pages.

FURTHER DEVELOPMENTS IN INFANT HYGIENE

Analyzing the infant deaths according to the age of the infant, it became increasingly apparent that the reduction of infant mortality achieved during the first three decades of the present century had benefited mainly infants who had already passed through their first month of life. The table (p. 286) giving New York City's experience is typical of conditions in other parts of the United States.

Neonatal Mortality.—It will be seen that the reduction in the death rate of infants under one month of age has been far less than that in older infants. Health administrators are therefore giving increasing attention to *neonatal mortality, i. e.*, the death rate of infants under one month of age. In

NEONATAL MORTALITY, NEW YORK CITY, 1910–1940 INCLUSIVE

Year.	Births.	Deaths under 1 year.	Infant mortality rate.*	Deaths under 1 month.	Neonatal mortality rate.*
1910	143,000†	16,215	113.4	5268	36.8
1911	141,000†	15,053	106.8	5274	37.4
1912	140,000†	14,289	102.1	5165	36.9
1913	140,000†	13,780	98.4	5088	36.3
1914	140,647	13,312	94.7	5122	36.4
1915	141,256	13,866	98.2	5067	35.9
1916	137,664	12,818	93.1	5061	36.8
1917	141,564	12,568	88.8	5104	36.1
1918	138,046	12,657	91.7	5118	37.1
1919	130,377	10,639	81.6	4535	34.8
1920	132,856	11,340	85.4	4650	35.0
1921	134,241	9,548	71.1	4571	34.1
1922	129,684	9,666	74.5	4275	33.0
1923	129,160	8,578	66.4	4132	32.0
1924	130,436	8,820	67.6	4346	33.3
1925	128,790	8,315	64.6	4222	32.8
1926	125,515	8,509	67.8	4058	32.3
1927	128,889	7,210	55.9	3859	29.9
1928	126,332	8,280	65.5	4022	31.8
1929	124,404	7,281	58.5	3779	30.4
1930	122,811	7,030	57.2	3753	30.6
1931	115,621	6,427	55.6	3347	29.0
1932	109,878	5,594	50.9	3238	29.5
1933	103,500	5,508	53.2	3099	29.9
1934	101,239	5,287	52.2	3154	31.2
1935	100,657	4,790	47.6	2933	29.1
1936	98,507	4,490	45.6	2770	28.1
1937	101,988	4,457	43.7	2711	26.6
1938	102,045	3,910	38.3	2524	24.7
1939	102,261	3,795	37.1	2533	24.8
1940	107,287	3,749	34.9	2618	24.4

* Per 1000 live births. † Estimated.

1910 the neonatal mortality in New York City was 36.8 per 1000 live births; the mortality in the remaining eleven months of the first year was 76.6. In 1940 the neonatal mortality was 24.4; the mortality for the remaining eleven months was only 10.5! Thus we see a reduction in the neonatal mortality from 36.8 to 24.4, a reduction of about 33 per cent in the course

of thirty years. In contrast to this the mortality of infants for the remaining eleven months of the first year, declined from 76.6 to 10.5, a reduction of 86 per cent in thirty years.

It is instructive to study the neonatal deaths in more detail, as is shown in the table.

INFANT DEATHS, NEW YORK CITY, 1939, BY AGE AND SEX

Deaths.	Males.	Females.	Both sexes.	Per cent.
First day	818	537	1355	35.7
Rest of first week	437	286	723	19.0
Second week	90	80	170	4.5
Third week	79	66	145	3.8
Fourth week	73	67	140	3.7
Total under 1 month	1497	1036	2533	66.7
Total during first year	2204	1589	3793	100.0

It will be noted that of the 3793 infants dying in the first year, over 35 per cent died within the first twenty-four hours and well over 50 per cent within the first week. This is the period when the mother and her baby are still under the obstetrician's care, and it is therefore *primarily to the obstetrician that we should look for any reduction in these infant deaths.* This is also brought out by an analysis of the causes of death, such as is shown in the following table:

INFANT DEATHS, NEW YORK CITY, 1939, BY CAUSE

Deaths.	Causes peculiar to newborn.	Infectious diseases.*	Respiratory diseases.	Gastro-intestinal diseases.	All others.	Total of all causes.
Under 1 month	2229	15	119	106	64	2533
Over 1 month	241	111	461	215	232	1260
Total under 1 year	2470	126	580	321	296	3793

* Except pneumonia and other respiratory infections.

The two tables just considered relate only to the deaths of infants who were born alive. They do not give a complete picture of the wastage of infant lives at or near birth, because they do not show the large proportion of babies born dead

even though they had completed seven months or more of utero-gestation. The true picture is well brought out by the graph showing by months the deaths of live-born infants, and the stillbirths.

Prematurity.—Among the causes of death peculiar to the newborn, deaths charged to "prematurity" constitute the major part. Other prominent causes are injury at birth,

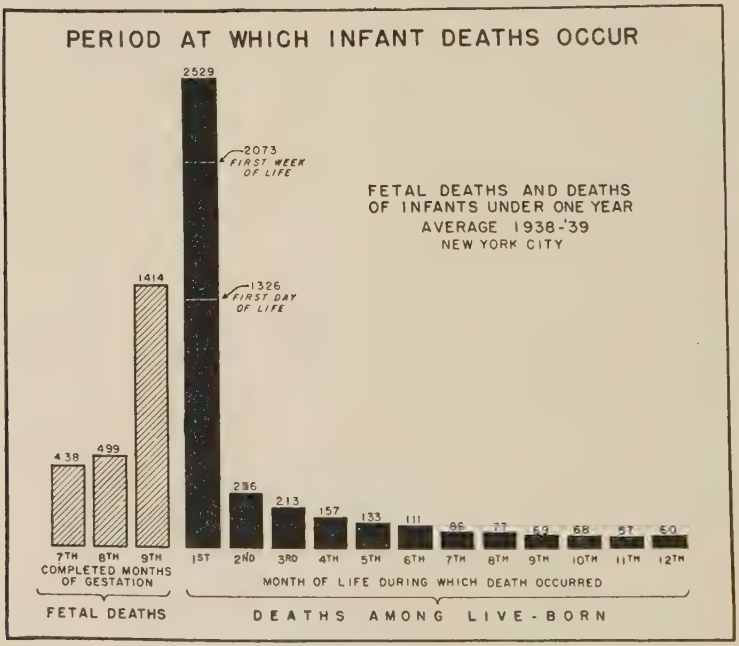


Fig. 86.

asphyxia, atelectasis and congenital malformation. Altogether this group makes up nearly 90 per cent of the infant deaths during the first month. Efforts to reduce the mortality for these young infants should therefore be directed mainly to this group of causes, and especially to prematurity, injury at birth and asphyxia. Probably little can be done to reduce deaths caused by congenital malformations and a few other causes, but fortunately their number is relatively small.

Deaths charged to "prematurity" amount to nearly one-third of all deaths in infants under one year of age, and they deserve far more attention than health officers have given them. To some extent this neglect has perhaps been due to the feeling that such premature infants were so handicapped that it were better to make no attempt to raise them to maturity. This view is presented by Stouman* who points out that neonatal deaths comprise a large proportion of the infants unfit to live at all, the death of the infants being due largely to causes which appear to be selective. Granting that this may be true in some cases, it is certain that a considerable number of these lives could and should be saved without rearing any significant proportion of infants unfit to live at all.

The latter view is supported by the excellent results obtained by Dr. Julius Hess of Chicago, who for years has devoted a great deal of attention to the rearing of premature infants. Hess insists that a worth-while proportion of these prematures can be raised to maturity and shows that a careful physical and psychologic examination of his "graduates," as he calls them, proves them to be in no way inferior to a comparable group of children who had been born at term.

The plans developed by Hess, whereby communities can successfully deal with the problem of prematurity, deserve wider adoption.

Birth Injury.—The next largest group of infant deaths due to obstetrical conditions is "injury at birth." In an effort to gain an insight into the cause of these deaths, Bolduan in 1933 had an item added to the New York City birth certificates, asking the attendant at birth to state the mode of delivery. The table on page 290 shows the information thus obtained from the birth certificates filed in 1939.

This marked the first attempt anywhere to secure clinical information from birth certificates which would serve the health authorities in devising control measures. The plan proved so successful that it was extended by Duffield, director of the statistical bureau of the New York City health depart-

*Stouman, K.: Quarterly Bulletin, Health Organization, League of Nations, vol. III, No. 4, 1934.

BIRTHS, NEW YORK CITY, 1939, SHOWING MODE OF DELIVERY

	Number.	Per cent of total births.
Total births	102,261	
Normal, nonoperative delivery	67,750	67.4
Episiotomy only	7,729	7.7
Forceps	20,613	20.6
Version	421	.4
Breech extraction	1,478	1.4
Cesarean operation	2,506	2.5
	100,497	100.0
Mode of delivery not stated	1,764	

ment. At the beginning of 1939 he introduced a new birth certificate (also one for fetal deaths) in which confidential information must be supplied on the back of the certificate.*

The statistical bureau now transfers all this information to the punch cards for each infant death. In New York City it is therefore possible to review each infant death (also each maternal death) in the light of the valuable data for mother as well as infant, supplied on the back of each birth certificate. The methods developed by the New York City authorities constitute a practicable plan for dealing with neonatal mortality, and promise to bring about a substantial reduction in the infant death rate.

Infant Mortality in American Cities.—In the table on page 291 are shown the infant mortality rates of the larger American cities.

In 1929 only two of the cities listed had an infant mortality rate under 50 per 1000 live births, namely Portland a rate of 43, and Minneapolis a rate of 49. San Francisco had an even 50. In 1939 there were 21 cities with infant mortality rates under 50, and six of these had rates below 40.

Among the five cities with a population over a million, Chicago for the eighth consecutive year again carried off the honors in 1939, with a rate of only 31.

Helpful Legislation.—Before leaving this subject mention should be made of two New York State laws which should be of considerable influence in affecting the number of infant deaths and stillbirths. One requires a blood test for syphilis

* Duffield, Thos. J.: Bull. N. Y. Acad. Medicine, Nov., 1940.

INFANT MORTALITY—26 AMERICAN CITIES—1930–1939

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
New York	57	56	51	53	52	48	46	44	38	37
Chicago	54	57	49	49	48	40	39	38	34	31
Philadelphia	64	64	52	49	54	49	48	45	40	43
Detroit	65	56	52	51	50	45	53	43	41	40
Los Angeles	62	59	56	57	53	53	56	52	43	40
Cleveland	54	54	53	44	45	44	43	44	36	46
Baltimore	65	74	62	61	65	57	67	57	53	41
St. Louis	54	63	56	45	61	52	50	51	41	35
Boston	70	61	59	59	55	51	52	51	46	42
San Francisco	40	41	39	40	33	35	41	33	29	29
Pittsburgh	69	70	67	53	55	50	52	52	43	46
Washington, D. C.	71	67	73	67	65	59	72	61	48	48
Milwaukee	58	58	47	47	45	46	46	39	40	39
New Orleans	88	75	75	81	82	77	93	79	81	69
Minneapolis	55	61	54	49	47	43	44	39	34	34
Cincinnati	65	71	55	59	64	61	61	56	47	43
Newark	51	49	41	43	45	51	44	37	39	38
Kansas City, Mo.	68	69	57	52	59	58	56	51	46	44
Indianapolis	64	58	61	61	67	67	63	67	60	48
Houston	*	*	*	61	68	58	56	60	53	53
Louisville	67	77	67	66	71	54	68	56	55	51
Columbus, Ohio	71	62	61	69	58	55	62	49	44	56
Jersey City	72	74	54	41	45	41	35	34	35	54
Portland, Ore.	41	36	34	38	36	34	39	36	31	34
Toledo	56	56	62	59	53	54	48	53	46	44
Denver	93	70	69	55	63	60	63	64	51	46

Rates for 1930–1938 for all cities except New York copied from Bureau of the Census, Special Reports, Vol. 9, No. 15.
* Not in birth registration area.

as a prerequisite to the issuance of a marriage license. The other requires such a blood test of all expectant mothers.

Infant Mortality Among Negroes.—A study of the infant death rates reveals that many of the southern cities have rates considerably higher than those prevailing in the North. This must not be taken as necessarily a reflection on the health work in these cities, for analysis shows that the high rates are due to the large proportion of Negroes in the population. How this affects the infant death rate can be seen by studying New York City's statistics. In the Borough of Manhattan the infant death rate in 1939 was 45.7 per 1000 births; it was 42.1 for whites and 56.8 for Negroes. One must bear in mind that, on the whole, the economic status of the Negroes is decidedly lower than that of the whites. Almost invariably they live in the poorer, more crowded, less sanitary sections of a city. In many instances the wife as well as the

husband is a wage earner. Under these circumstances it is clear that the infants do not receive the amount and kind of attention which they should have. Breast feeding is less common for the same reason. These factors, rather than any racial peculiarity, are responsible for the high infant death rate among Negroes.

Illegitimacy.—The infant death rate is always higher among illegitimate children than among others. This is due to the fact that an unduly large proportion of these unfortunates cannot be breast fed, for they have been abandoned by their mothers, *i. e.*, they are foundlings. But even when this is not the case, it is the exception that the mother can give her infant the care and attention which a married mother can. The unmarried mother usually has a hard struggle to care for herself and her baby. No wonder, then, that many feel no incentive to keep the baby alive. The statistics concerning illegitimacy in this country are very incomplete, and the reported figures are undoubtedly much below the true number.

In dealing with foundlings one can either send them to special institutions or board them out in private homes maintained under supervision of the health authorities. Experience shows that the latter plan is preferable, and is attended with a lower infant death rate.

For certain other factors influencing the infant death rate see Social and Economic Aspects of Disease, page 75.

CHILDBEARING

From what has been said it is clear that being born is not without risk for the infant. Giving birth to a child is a risk also for the mother.

In the United States at the present time nearly five mothers lose their lives, through some cause related to the termination of pregnancy, for each thousand live births. We call this the *maternal mortality rate*. This term is not quite accurate because a variable proportion of the deaths occur in women following either a spontaneous or induced abortion. Obviously, such deaths should not be counted as a hazard of *childbirth*. However, for the sake of uniformity and compara-

bility of statistics, it has been found advisable to employ the term "maternal mortality rate" for the number of deaths causally related to births, to stillbirths (seven months or more of pregnancy), and to spontaneous or induced abortions (less than seven months of pregnancy) per 1000 live births.

Just what are the special dangers associated with childbearing? By far the greatest single cause of death is infection. Next in frequency come hemorrhage, toxemias of pregnancy including eclampsia, ectopic gestation, and other accidents of childbirth including cesarean operation.

Prior to the demonstration by Pasteur of the germ origin of infectious diseases, death due to infection, at that time called "childbed fever," often carried off 10 per cent of the mothers in childbirth. Semmelweis in Europe and Oliver Wendell Holmes in this country insisted that the condition was contagious, and that the infection was often carried by the attendant at birth. In 1840 an outbreak of childbed fever in the Lying-in Service of the Almshouse Hospital (the predecessor of Bellevue) caused 19 deaths among 59 women confined. Even as late as 1874, out of 116 women confined at Bellevue hospital, 31 died of childbed fever. Today, with scrupulous attention to asepsis, the maternal mortality rate in the entire city is down to 3 per 1000 births, and puerperal infection ("childbed fever") is responsible for less than half this total. Furthermore a large proportion of the deaths from puerperal infection occur as the result of induced abortions.

From what has been said it is clear that the problems presented by maternal mortality are largely the responsibility of the obstetrician. But by no means entirely. Too large a number of expectant mothers fail to place themselves under his care during the early months of pregnancy. They frequently present themselves only as emergency cases, when labor has already begun, or when some serious complication (toxemia, hemorrhage, etc.) has developed. It is the responsibility of the health authorities to carry on intensive health education and to organize a system of free prenatal care for those in the lower income brackets. Such care, begun early in the course of pregnancy, will prevent many of the deaths now making up our maternal mortality.

Prenatal Work.—Although discussed at this point, prenatal work has an important and necessary part in the program for saving the lives of infants as well as those of the mothers. Among the causes of infant deaths there are clearly some diseases of the newborn which we cannot prevent. Others, however, such as prematurity, injury at birth, congenital debility, and congenital syphilis are distinctly amenable to preventive measures. Similarly, there are some conditions affecting the mother in which timely preventive measures are of great value. To carry on this work, it is necessary that expectant mothers be encouraged to place themselves under proper medical supervision as early in pregnancy as possible. To facilitate this, health departments have established prenatal clinics to which mothers are urged to come for examination and for advice regarding the hygiene of pregnancy. Blood tests are made to discover an unsuspected syphilitic infection; regular testing of the urine is undertaken in order to detect any beginning disturbance of the kidney; pelvic measurements are made to determine the presence of a deformed or otherwise abnormal pelvis; the mother is instructed regarding her diet, her clothing, the need for exercise and rest; arrangements are made for proper medical care during her confinement. In short, everything is done to safeguard the mother and her offspring at this critical period.

In the case of the indigent the program here outlined is not so difficult to carry out. Among the somewhat better situated, however, one must be careful not to place the health authorities in the position of seeming to push the family physician aside. As a matter of fact, a very large part of the program here outlined is distinctly the work of the family physician, and no one is better fitted for it. It must be the aim of health authorities to arouse public interest in prenatal work, to convince them of its great importance to them, and so to organize it that an increasing number of mothers will learn to place themselves under proper medical supervision at an early period of pregnancy. Mothers should be taught what "proper medical supervision" means, and why certain examinations, measurements and tests should be made. They should be warned of the dangers of unnecessary instrumental interference, and of the advantages of patience during the

trying ordeal of childbirth. Obstetrical authorities feel that unnecessary and harmful instrumental interference is frequently undertaken because of the urging of mothers who desire to go through labor painlessly.

Midwives.—In Europe a very large proportion of the births is handled by midwives. On the whole their work appears to give satisfactory results, for in many European countries, especially Holland and the Scandinavian countries, the midwives are well trained and adequately supervised. In the United States, however, there is the greatest diversity in the requirements exacted of midwives in the different states, and a large number of insufficiently trained and unqualified women are undoubtedly engaged in the practice of midwifery. It is the function and the duty of health authorities to supervise the work of midwives, to establish and enforce adequate standards of training, and assist in establishing training schools. In New York, where constant supervision of midwives is exercised, their work has proved entirely satisfactory. However, standards enforced by the Department of Health have greatly reduced the number of midwives practicing in the city, so that, whereas twenty years ago, 40 per cent of the births in New York were attended by midwives, at present the number is only 3 per cent. In outlying rural districts the provision of properly trained attendants at birth presents a serious problem.

* * * *

From what has been said of infant and maternal mortality, it is clear that much still remains to be done in this field. It is all the more imperative because of the marked decline in the birth rate during the past quarter century. We cannot afford the present wastage of precious infant and maternal lives. Health administrators have the responsibility of making the public realize that these lives are one of our most valuable natural assets, that many of them can be saved, and that their conservation is of the highest importance to the future of the nation.

CHAPTER XL

SCHOOL MEDICAL INSPECTION

THE ultimate responsibility for the health of the school child rests with the parent and the family physician. This fundamental principle should never be forgotten in any school health program. There are, however, definite provisions which the school authorities should make in supervising the health of the school child. These include school hygiene, control of communicable diseases, detection of physical defects which may interfere with the child's progress, and health education of the school child.

Environmental Hygiene.—In the supervision of school hygiene, attention must be paid to the size of the classrooms, the provisions of good ventilation and lighting, drinking fountains, sanitary toilets, adequate cloakrooms, and the control of showers and swimming pools. In addition, the school medical inspector should see that the location of the school buildings is satisfactory from a sanitary standpoint. Where the children receive meals at school, there should be medical supervision of any food handlers.

Control of Contagion.—In the control of communicable diseases it is not necessary to make an accurate diagnosis in every case, for the chief aim of the procedure must be the detection of all children presenting suspicious symptoms, to the end that such children may be excluded from school and examined by their family physician. Any child showing evidence of acute illness or suggestive signs at the daily inspection by the teacher should be referred to the school nurse. Thus a high degree of teamwork in this phase of school health work is necessary. All cases suspected of being one of the notifiable contagious diseases should at once be reported to the health officer. Once a case has been discovered and reported, full responsibility for further preventive measures may well be placed on him.

Physical Defects.—A most important part of the work of school medical inspection consists in the detection of physical

defects. In so far as possible, each child should receive a careful physical examination by a qualified physician on entering school, and at least three times throughout its school life. A record of the findings should accompany the child from class to class. A simple form of examination card should be given to the parent, with the request that it be filled in by the family physician.

In making the examination, particular attention should be given to the following:

Defective vision.
Defective hearing.
Defective nasal breathing.
Hypertrophied tonsils.
Defective teeth.
Defective nutrition.
Cardiac disease.
Pulmonary disease.
Orthopedic defects.
Nervous diseases.
Mental defectiveness.

In examining for *defects of vision* it is customary to have the child read the letters on a Snellen test card placed in a good light. The child is placed 20 feet in front of the card and one eye is covered with a card, while the vision of the other is tested. The various sized letters are numbered, showing the distance at which they can be read by a normal eye. The degree of vision is expressed in the form of a fraction in which the numerator is the distance (in feet) at which the test is performed, and the denominator the number of the letter read. Thus, if at 20 feet the eye reads correctly nothing smaller than the letters marked 60, we say the eye has 20/60 vision.

Experience has shown that many children whose vision is really 20/60 can force their eyes to read 20/20 by straining the muscles which bring the object into focus. These muscles of accommodation can be paralyzed by the use of eye drops containing atropine or similar drugs. Such drugs are spoken of as *cycloplegics*. A normal eye after the use of a cycloplegic is still able to read 20/20 on the Snellen test card. An eye, however, which has forced itself, by straining the muscles of accommodation, to see 20/20, will reveal its defectiveness

after the use of a cycloplegic. It may then be able to read only 20/60, or even less. How large the number of school children may be who thus constantly strain their eyes is indicated by studies made by the United States Public Health Service, under the direction of Dr. Taliaferro Clark. These showed that about one third of the children who tested 20/20 when no cycloplegic was used, did so only because they strained their muscles of accommodation.

Nurses and teachers should therefore be on the watch for symptoms of eye strain among their pupils, and should report all such cases to the school physician. It is desirable also to test the children's vision after the use of a cycloplegic, but to do this the consent of the parents should be obtained.

According to recent surveys, about 3 to 4 per cent of school children have *defective hearing* of slight to severe degree. It is important, therefore, that an audiometric test be included in the school health examination. There are two ways of accomplishing this. The group method is used for gross screening and this is followed by the individual test of those who have been found defective in the group. When a hearing defect has been found, the child should have a thorough examination by a trained otologist.

In examining for *cardiac* and *pulmonary defects* an effort should be made to examine the children stripped to the waist. This can usually be done only with the consent of the parents. Whenever possible, school medical examination should be conducted in the presence of the parents, for it furnishes the best possible opportunity to enlist the cooperation of the parents in the correction of physical defects. It is sometimes very difficult to decide whether certain cardiac conditions are organic defects or not. In such cases, repeated observation and possibly skiagraphic examination (*x*-rays) may clear up the diagnosis. Such examinations, however, are not undertaken by the school physician, but by the family physician to whom the child is referred.

The making of *intelligence tests* should be left to properly trained experts. The tests are usually carried out by the Binet method or one of its modifications. In this connection it may be well to quote Dr. Frankwood Williams, Medical Director of the National Committee on Mental Hygiene:

"There is nothing in her training as a nurse that qualifies her as an expert in any of these fields. Should she wish to qualify for such work there is only one way, and that is by special additional training.

"The method of testing looks easy. Any intelligent person, it would seem, should be able to ask a series of questions and record the answers. The intelligence test, however, is a highly technical procedure. No one, whether nurse, doctor, social worker, or school teacher, should be permitted to use them unless they have been technically trained in the use and interpretation of the tests. A few lectures on the theory or use of the tests qualifies no one for such work. Training under supervision is necessary.

"The intelligence tests when properly used are instruments of much importance. Any individual well trained in their use and interpretation can throw a very considerable light upon problems with which nurses, teachers, and social workers are wrestling. Those most expert in their use, however, know of the many pitfalls that must be avoided, of the serious mistakes it is easy to make, both in the giving of the tests and in their interpretation, of how relative judgment drawn from them must be, and of the inadequacy of the tests alone as a diagnostic measure."

With the aid of the school nurse an effort must then be made to secure the correction of all remediable defects found. In the case of other defects, such as cardiac, pulmonary, mental, and certain types of visual defects, it may be possible to place the child in special classes, such as open-air classes, sight-conservation classes, ungraded class for mental defectives.

Health Education.—Health education and education in personal hygiene should become an integral part of the child's whole educational program. In order best to accomplish this, close cooperation between school health authorities and the teaching staff is desirable. Teachers may be guided by lectures on the various aspects of public health and preventive medicine as related to the school child. They in turn may use the field of medicine and its allied subjects as sources for illustrative material in their class work. For instance, a ten-year-old child may be given figures from the vital statistics of his town for examples in arithmetic, or a high school pupil may be taught the importance of tuberculosis by reporting to the school paper on the care of the tuberculous in his community. It is important that all material thus used be subject to review by the school physician in order to insure its scientific accuracy.

CHAPTER XLI

PUBLIC HEALTH NURSING

Public health nursing, as defined by the National Organization for Public Health Nursing,* is "an organized community service, rendered by graduate nurses to the individual, family and community. This service includes the interpretation of medical, sanitary and social procedures for the correction of defects, prevention of disease and the promotion of health and may include skilled care of the sick in their homes."

According to this authority the *objectives* of public health nursing are:

"To assist in educating individuals and families to protect their own health.

"To assist in the adjustment of family and social conditions that affect health.

"To assist in correlating all health and social programs for the welfare of the family and community.

"To assist in educating the community to develop adequate public health facilities."

Historical.—The past forty years have firmly established the trained nurse as an indispensable agent of public health administration. The care of the sick in the homes by those who make such work their chosen career has of course existed for many centuries. During the Middle Ages the monasteries and convents stood for all that was then best in nursing, and it was the Church which gave rise to and fostered nursing orders. Public health nursing in its modern sense, however, stems largely from England. After several abortive attempts to organize the care of the sick in their homes by trained nurses, there was established in that country (1875) the

* "Manual of Public Health Nursing," Ed. 2, The National Organization for Public Health Nursing, New York. By permission of The Macmillan Company, publishers, 1932.

Metropolitan and National Nursing Association, with its great departure from previous methods in the employment only of nurses drawn from the ranks of educated women. In the United States, apart from the Sisterhoods, the first organization systematically to send trained nurses into the homes of the "sick poor" was the Woman's Branch of the New York City Mission (1877). Thirteen years later there were twenty-one organizations engaged in visiting nursing. These had no connection with one another, and no common standard of efficiency, either in practical work or in the educational requirements for the nurses. Each city or town started its visiting nurse work in its own way and continued in its own way with the divergence of method to be expected under the circumstances.

Forty years ago, when the first public health campaigns were started in this country, nursing care of the sick in the homes was fairly well established. With the further development of medical science, there was need for disseminating the knowledge of disease prevention and health promotion to all groups and classes of people, and the public health nurse accepted the responsibility for this health education. The general public had little appreciation of the need of scientific knowledge in this field, and the nursing profession deserves great credit for realizing the possibilities of this great humanitarian movement.

In 1898 Los Angeles was the first city to inaugurate municipal nursing. In 1902 the New York City Department of Health engaged nurses to assist in the health supervision of school children. Later it assigned nurses to make home visits to the tuberculous, and to supervise the home isolation of those ill with diphtheria, scarlet fever and other contagious diseases. The innovation was a great success, for these pioneer municipal nurses made good. Public health nursing was gradually extended until it is now available in most of our rural communities. Today, health administrators wonder how one could ever get along without a staff of public health nurses, for there is scarcely a public health activity in which we do not rely on the public health nurse for valuable service. The increase in the number of nurses has been exceedingly rapid. In 1900 there were only 130 public health nurses in

the United States, while now, forty years later, there are over 25,000 which, according to the best estimates that have been made, is one third the number actually needed to carry out the health programs outlined by many experts.

During the early development of public health nursing there was a tendency to employ the individual nurse for some special service, such as school nursing, tuberculosis or infant hygiene work. With the continued expansion of the field, by the addition of maternity service, control of communicable disease, venereal disease and other specialities, the duplication of visits by different nurses to the same family, has become a serious question. To meet this problem, many communities are adopting what is spoken of as "generalized nursing service." This plan provides for the assignment of a nurse to a certain area or district in which she gives all types of service required by any member of the families in her unit of population. While this generalized program makes greater demands upon the ability of the individual nurse than does a specialized service, it is believed that the advancement in the standards of selection and education of nurses will equip the individual nurse to discharge these manifold duties with better results for the family.

An appreciation of the fact that sociological and psychological factors are intimately bound up with our health problems has made it more necessary for the leaders in public health nursing to devise and conduct educational programs, most of them sponsored by universities, to meet the growing demands for competent staff nurses, supervisors and administrators in the field of public health nursing. Health administrators have already begun to demand definite qualifications for nurses to meet these increasing demands, and in the course of time the qualifications will no doubt be made more stringent. With a growing realization of the value of this service, communities will, it is hoped, be willing to pay qualified nurses the compensation to which they are entitled. This will be an incentive to well educated young women to adopt public health nursing as a career.

Scope of Public Health Program.—The following services are most commonly provided for in a public health program:

Tuberculosis nursing includes general supervision of regis-

tered cases, the placement of patients in institutions, rendering bedside care when indicated, and instruction in hygiene of the disease. Besides this, it is the function of the nurse to refer persons who have been in contact with an infected person and those with symptoms of the disease to a physician for examination.

Maternity nursing includes prenatal, partum and postpartum care and instruction. The nurse persuades the patient to register with the physician early in pregnancy and then keeps her under observation, reporting all symptoms to the physician. She also helps to interpret the physician's recommendations, assists the patient to carry out the plan for her care, and instructs her in the hygiene of pregnancy and in preparation for the baby. The actual obstetrical care is often given in a hospital, although many public health nurses care for patients delivered at home by the physician. During the postpartum period, the nurse not only instructs the mother in her own care and the care of the newborn baby, but she also explains the need for continued medical supervision of the baby during infancy and the preschool period. In the child welfare program the nursing service involves a wide variety of activities, such as instructing the mother regarding the physician's recommendations and giving advice on general care, assisting at well-baby and preschool conferences, conducting mothers' classes, supervising licensed midwives, and inspecting and supervising infant boarding homes.

School nursing was first employed solely for communicable disease control by excluding children suffering from communicable disease, following these excluded children to see that they received proper care in the homes so that they might return to school as soon as possible. Later, as the school program was developed to include the examination of children to find physical defects, it became the responsibility of the nurse to interpret to the parents the needs of their children and to persuade them to have remedial work done. From these early beginnings the school nursing program has developed until it now includes various activities for promoting health which are shared in by the home, the school and health workers. The school was one of the first agents to employ the nurse in a public health education plan.

Communicable disease control, primarily the responsibility of the official health agency, uses the nurse to instruct families in sanitation and hygienic measures, in the establishment and termination of quarantine, and in taking cultures or specimens. It should be mentioned, however, that many public health nurses not directly associated with the municipal agency share in this program.

Any one or all of the above types of nursing service for a community may be conducted by a private agency, but most official agencies accept as their responsibility the assurance that an adequate service is available. It is the function of the public agency to assist in every way possible to coordinate the nursing work of the private and public agency so that the combined services will be most effectively used for the complete protection of public health.

CHAPTER XLII

HEALTH EDUCATION

A CENTURY ago, marked advances were made in public health as the result of the sanitary reforms initiated in England by Chadwick, Simon, Florence Nightingale and others. Here were benefits conferred *on* the people by the introduction of pure water supplies, by housing reform, labor legislation, street cleanliness, the disposal of garbage and rubbish, and similar sanitary measures. The people, in general, were passive recipients; they did not need to cooperate actively. In the state of scientific knowledge of communicable diseases the control of such diseases, with one exception, was limited to isolation and quarantine. The exception, of course, was smallpox, for which vaccination was available since the close of the eighteenth century. Almost everywhere up to nearly the end of the nineteenth century the control of the communicable diseases was undertaken as part of the police activities. The people were ordered to do this, and to refrain from that. In many countries this is still the chief reliance of administrative authorities; in these countries, also, public health administration is usually but a branch of police administration.

In the United States, largely through the influence of Biggs and his contemporaries, public health administration has developed along quite different lines. Stimulated by the remarkable advances which had just been made in our understanding of the nature of communicable diseases and their mode of spread, and realizing the value of active, intelligent public cooperation, Biggs early began a campaign of public health education to acquaint the people with this newer knowledge. As early as 1889 we find Biggs preparing the first popular circular of information on tuberculosis, and then for the next ten or fifteen years carrying on a continuous educational program on all phases of this disease. In time

he extended this educational work to other diseases, such as diphtheria, typhoid fever, malaria and pneumonia; and what is particularly important, he included physicians as well as the general public among those whom he sought to influence. In short, he relied largely on health education, in the broadest sense, in order to obtain that degree of voluntary cooperation which he regarded as indispensable for securing the greatest benefits from the advances in medical science.

In 1914 the New York City Department of Health was the first to establish a special bureau of health education in order to coordinate and develop this important phase of public health work. Since then the example has been widely copied so that now, in the United States, public health education is everywhere regarded as an essential part of the administrative program. In this respect American practice differs from that in most European countries, where police methods still loom large in public health work.

Scope of Health Education.—In developing the educational work in New York City, the senior author has ever regarded the *practicing physician* as the most important factor in the program. Until recently the training of physicians was directed almost exclusively toward the diagnosis and treatment of disease. The health department must therefore devote considerable attention to the dissemination of scientific information regarding the public health aspects of disease, and especially to helpful advice regarding preventive measures. This is best accomplished by the publication of a bulletin, supplemented by courses of lectures, scientific exhibits, refresher courses of instruction, laboratory demonstrations, circulars of information, and other devices.

The next important group to be considered is that of the *school children.* Almost every modern school now has definite graded instruction in health and hygiene, from the lowest grade in the elementary school through the entire course in the high schools. From experience the writers know that this instruction may well be left with the school authorities. The health officer should, of course, be ready and willing to assist in various ways in making this instruction interesting, helpful and particularly adapted to the community's needs. Such assistance may take the form of supplying circulars and

pamphlets or exhibit material, or, in the high school, of supplying microscopic slides, specimens of plates of milk counts, samples of outfits for throat cultures, and the like. Lantern slides, motion pictures and lectures will also be acceptable.

In the education of the *general public,* use is made of all the various vehicles such as newspapers, radio broadcasts, motion pictures, exhibits, billboards, lectures and the distribution of health leaflets. Each of these has its advantage as well as its limitations. Usually all should be employed, though often the extent to which the various vehicles are used will be limited by the available budget.

Scientific accuracy must always be the aim of all the educational work of the health department. Armstrong recently emphasized this point and cited a number of instances in which unscientific statements had been adopted as slogans by health workers.

A large part of a health department's educational work should be done by the nurses in the baby health stations, prenatal clinics, and in the course of their visits to the homes. For this reason such nurses should constantly receive adequate instruction throughout their service so that they may be kept abreast of advances in the field of public health.

PART V. HEALTH ADMINISTRATION

CHAPTER XLIII

HEALTH ADMINISTRATION

FEDERAL

Much misconception prevails regarding the respective functions and responsibilities of federal, state and local authorities in dealing with matters of public health. Not infrequently one reads of the "United States Board of Health," as though there were some supreme health authority to which state and local authorities were subordinate. This, of course, is not the case. In fact there is no United States Board of Health.

The constitution of the United States was ratified by a convention of the States on September 17, 1787. On the ground that it was not explicit enough, the First Congress, in 1789, adopted and submitted to the States certain proposed amendments. Ten of these, popularly spoken of as the "Bill of Rights," having been ratified by the States, were declared in force December 15, 1791. The last of these ten amendments states:

"The powers not delegated to the United States by the Constitution, and not prohibited by it to the States, are reserved to the States respectively, or to the people."

Inasmuch as the protection of the public health is not delegated to the United States, its supervision and control is a state function.

There is, however, among the powers delegated to the Congress of the United States the following specific provision:

"Congress shall have power to regulate commerce with foreign nations, and among the several States, and with the Indian tribes."

Moreover there is the "general welfare" clause, which empowers Congress to lay and collect taxes, duties, etc., "to pay the debts and provide for the common defence and general welfare of the United States."

It is under these provisions that the Federal government has carried on important health activities in this country, most of them through the Public Health Service, until recently a bureau in the Treasury Department. Activities in the field of maternal and child health have been carried on by the Children's Bureau of the Department of Labor. Food and drug control has rested with the Department of Agriculture.

Under the stimulus of the economic and industrial depression which followed the stock market crash in 1929, Congress began to enact legislation which greatly extended the interpretation of the "general welfare" clause of the Federal constitution. For us, as students of public health, the more important of these laws are three, namely, the Social Security Act of 1935, the National Cancer Act of 1937, and the Venereal Disease Act of 1938. Furthermore, Congress gave the President authority to reorganize the executive departments and agencies.

Under Title VI of the *Social Security Act,* authority is granted for an annual appropriation of not to exceed $8,000,000 for the purpose of assisting states and local health districts in the establishment and maintenance of adequate health services, including the training of personnel, and an annual appropriation of not to exceed $2,000,000 to the Public Health Service for research activities and expenses of cooperation with the states in the administration of Federal funds granted in aid for improved state and local health services.

The *National Cancer Act* provides for the establishment of the National Cancer Institute, for the purpose of conducting researches, investigations, experiments and studies relating to the cause, diagnosis and treatment of cancer; for assisting and fostering similar research activities by other agencies, public and private; and for promoting the coordination of all such researches and activities and the useful application of their results, with a view to the development and prompt

widespread use of the most effective methods of prevention, diagnosis and treatment of cancer.

The *Venereal Disease Act* imposes additional duties upon the Public Health Service in connection with the investigation and control of venereal diseases, and provides for Federal grants-in-aid for the purpose of assisting states and local health districts in establishing and maintaining adequate measures for the prevention, treatment and control of the venereal diseases; for conducting studies and demonstrations to develop effective measures of prevention, treatment and control; and for the training of personnel. It also authorizes the appropriation of annual sums of $3,000,000, $5,000,000 and $7,000,000 in the first three years following the passage of the act, and for each fiscal year thereafter such sums as may be deemed necessary to carry out the provisions of the act.

Reorganization of Federal Health Services

For many years, yes, even decades, the criticism was made that the Federal health activities were administered by different executive departments. The major part was administered by the Public Health Service, a bureau of the Treasury Department; child and maternal health work was carried on by the Children's Bureau of the Department of Labor; the enforcement of the Food and Drugs Act was lodged with a division of the Department of Agriculture, although the control of serums and vaccines and of the arsenical compounds for the treatment of syphilis was placed under the National Institute of Health of the Public Health Service. With the enactment of the Social Security legislation, still another important agency dealing, in part, with health activities was created.

Faced with the problem of coordinating all these activities, the President made use of the authority granted him by Congress, and reorganized various government services.

Under the President's first Reorganization Plan, effective July 1, 1939, a new organization was created with the title *Federal Security Agency*. Member agencies in this new overhead organization are the Social Security Board, the Public

Health Service (previously in the Treasury Department), the Office of Education (previously in the Department of Interior), the National Youth Administration, and the Civilian Conservation Corps.

The Social Security Board administers old-age and survivors' insurance and the Federal features of the programs for unemployment compensation and public assistance. The Federal aspects of the other programs are administered by other Federal agencies. Most of these programs are on a Federal-State cooperative basis, those dealing with most phases of health requiring the approval of the Public Health Service. In the field of maternal and child health, however, state requests for Federal grants-in-aid must have the approval of the Children's Bureau (which is still in the Department of Labor).

In a subsequent executive order, June 30, 1940, the Food and Drug Administration of the Department of Agriculture was also transferred to the Federal Security Agency.

It is to be borne in mind that the Federal Security Agency is really a coordinating body, for the various government agencies thus brought together retain their identity and organization. We still have the Public Health Service, the Children's Bureau, the Social Security Board, the Food and Drug Administration, the National Youth Administration, the Civilian Conservation Corps, and so on. Hence we may continue to describe the Federal health activities under the names long familiar to us.

Excepting for activities in the field of child and maternal hygiene, most of the activities related to health are administered by the Public Health Service. The more important of these are described in the following pages.

Maritime Quarantine

The history of maritime quarantine has already been discussed (page 7), but a few words should now be said concerning the manner in which this quarantine is carried out. In this country until recently, maritime quarantine was left to the state health authorities. As a result the requirements at different ports were often so varied that conditions be-

came intolerable and the various states were induced to delegate this function to the Federal government. As at present conducted the work is under the immediate jurisdiction of the United States Public Health Service.

Every vessel arriving from abroad must bring with it a Bill of Health obtained from the United States consul at the port of departure and at every other port at which the vessel stops before its arrival at a port in the United States. This gives information about the vessel, its crew and passengers, and the health conditions at all ports at which the Bill of Health was issued.

On reaching quarantine the vessel awaits the arrival of an officer from the quarantine station. This officer, a physician, examines the bills of health, notes the prevalence of quarantinable diseases at the ports touched, and makes inquiries regarding the occurrence of illness among crew or passengers during the voyage. If there are any sick aboard at the time, he makes certain that the sickness is not one of the quarantinable diseases. Next he inspects the entire crew and all the passengers. If a case of illness is discovered that appears to be one of the quarantinable diseases he orders the patient removed to the hospital at the quarantine station, and, if necessary, he causes to be removed to the station all who have been in contact with the patient. He may detain the entire ship under quarantine until such time as may be necessary to prevent the introduction of a quarantinable disease into the country. If the vessel has come from a port where plague or yellow fever are prevalent, the vessel is fumigated before being allowed to proceed.

If the boarding officer is satisfied that there is no quarantinable disease aboard and that everything is in order, he issues a written permit, called a "pratique," for the vessel to proceed into port.

During the past few years the Public Health Service has expedited the passage of ships through quarantine by granting a radio pratique to passenger liners which regularly carry a ship's surgeon. Shortly before arriving at the American port of destination the ship's commander reports to the quarantine station by radio, giving certain specified information as to health conditions on the ship. If the quarantine officer is satis-

fied that there is no cause to detain the ship for examination, he may grant a "radio pratique," and permit the vessel to proceed directly to her dock without stopping at quarantine for inspection. The system appears to work satisfactorily.

In carrying out this quarantine activity the United States Public Health Service maintains trained medical officers at a number of the larger ports abroad. These see to it that vessels bound for the United States observe sanitary requirements while in the foreign port, and certify to this fact by countersigning the bill of health issued by the American consul.

An important activity carried on by the United States Public Health Service in connection with maritime quarantine consists in enforcing the regular fumigation of vessels in order to rid them of rats. This is done in order to prevent the introduction of bubonic plague, a disease of rats spread to man by the bites of fleas infesting the rats. Similarly, in preventing the introduction of yellow fever, ships are fumigated to kill the specific mosquitoes (Aëdes egypti) which carry this infection.

Interstate Quarantine

It is clear that *interstate* quarantine cannot ordinarily be carried out along the lines just described. In times of great peril, however, the Federal government not only has the power, but even the responsibility of taking all steps which may be necessary to prevent the spread of epidemic diseases from one state to another. Years ago, before we knew how yellow fever was transmitted, the government enforced stringent quarantine measures to prevent the spread of yellow fever from areas where the disease was epidemic. During the extensive epidemic of infantile paralysis in 1916, interstate quarantine measures were enforced to prevent the spread of the disease by travelers from one state to another. More recently the Federal government has effectively dealt with the transmission of psittacosis by adopting strict regulations for the interstate shipment of parakeets and parrots from infected areas.

At the present time the Public Health Service maintains

supervision of the drinking water supplied on the railroad trains and on steamboats engaged in interstate commerce (*e. g.,* Great Lakes steamers). It is also studying the pollution of the waters of the larger rivers, for these are frequently polluted in one state and used as drinking water in another. In cooperation with various state authorities it exercises supervision of the production and interstate sale of oysters, clams and other shellfish.

Medical Supervision of Immigration

In addition to the maritime quarantine activities already described, the United States Public Health Service maintains close supervision over the health of all immigrants arriving in this country. In carrying this out, all prospective immigrants applying to American consulates abroad for an immigration visa must first undergo a careful examination by a medical officer of the United States Public Health Service or its representative. Any pathologic condition which would make it likely that the prospective immigrant would become a public charge, or which makes his admission to the United States undesirable, is likely to result in a denial of the visa by the consul. In some conditions the consul is vested with discretion; in others a denial of the visa is mandatory. Among the former may be mentioned hernia, amputation, heart disease, senility, defective vision or hearing, varicose veins, goiter and crippling deformities. Mental disease (psychoses) and mental defectiveness, venereal disease, and tuberculosis, as well as certain loathsome diseases, are conditions which make exclusion mandatory.

It will be noted that these activities thus supplement those exercised by the quarantine stations. At the port of New York, for example, a steamer stops first at the quarantine station just inside the Narrows. As soon as the ship has been cleared there, it is boarded by customs and immigration inspectors. The latter examine the immigrant's visa, the medical officer looking for the endorsement of the Public Health Service representative. If this is present the medical officer may permit the immigrant to pass, though even then he may order the immigrant to Ellis Island for a further

medical examination. If the immigrant comes from a country in which the United States Public Health Service maintains no medical officers to examine applicants for visas, he is at once sent to Ellis Island for careful medical examination.

Control of Biological Products

The various biological products used in the diagnosis, prevention and treatment of disease are manufactured in a relatively small number of laboratories in this country and abroad. It is highly important that some authority supervise their production, potency and purity. Inasmuch as these products are largely sold in interstate and foreign commerce, this supervision and regulation is carried on by the United States Public Health Service, which requires the producers to obtain licenses and to conform to strict regulations laid down by the service. The more important of the products thus regulated are: diphtheria antitoxin, tetanus antitoxin, smallpox vaccine, typhoid vaccine, rabies vaccine, antimeningococcus serum, antipneumococcus serum, scarlet fever serum, tuberculin, insulin, salvarsan and other arsphenamines.

Other Health Activities

In addition to the activities already described, the United States Public Health Service does valuable work in conducting original investigations in the field of public health. Almost all of these are carried on in cooperation with state health authorities, often, in fact, at their request. Many of these have resulted in important contributions to our knowledge, as for example the work of Carter on malaria and yellow fever, that of Stiles on hookworm, Goldberger on pellagra, McCoy on plague, Anderson, Goldberger, Ricketts and others on typhus, Francis on tularemia.

Finally, health officers throughout the country look to the United States Public Health Service as the clearing house for exact information regarding the prevalence of communicable diseases throughout the country. Through a system of reports from state health officers and from its various field repre-

sentatives, the service constantly receives and tabulates such information and publishes it weekly in PUBLIC HEALTH REPORTS.

Altogether, despite the limitation of its administrative authority, the United States Public Health Service is a powerful and valuable factor in public health affairs throughout the United States.

CHAPTER XLIV

HEALTH ADMINISTRATION (Continued)

STATE

From what was said in the previous chapter it will be realized that the individual states are sovereign in matters of health administration within their borders. For this reason there still is considerable difference in the form in which the control and supervision of public health matters are organized in the various states. In the field of vital statistics (the registration of births and deaths) there has, to be sure, been attained a marked uniformity through the adoption by one state after another of the so-called "Model Registration Law" proposed by the United States Bureau of the Census, and enacted by the states largely through the efforts of Cressy Wilbur and William H. Davis. This pioneer work, together with the activities of the United States Public Health Service and the American Public Health Association, has gradually brought about a fair degree of uniformity in the general character of health work in the various states, even though not in its organization.

As a rule the states lodge the control and supervision of public health matters in a State Department of Health. In some cases the head of this department is the Commissioner of Health; in others it is a Board of Health. In some cases the secretary of this Board of Health is the chief executive office of the State Department of Health. There are states in which all the various public health laws must be enacted by the State Legislature; in other states the legislature has delegated this power to the Board of Health, or, as in New York State, to a Public Health Council. Similarly there is no uniformity in the manner of appointing the chief executive officer of the State Department of Health. In many states he is appointed by the Governor; in others by the Board of Health.

On the whole the functions entrusted to the Department

of Health in the various states are quite similar. However, in some states matters of water supply and sewage disposal are lodged with a State Engineering Department; in a few states the regulation of pharmacy is part of the health department's responsibility. Usually the supervision of foods is considered a health department's function, but in some states, for example New York, this is placed in the State Department of Agriculture. Industrial hygiene is sometimes administered through the Department of Health; in other cases, as in New York, through the State Department of Labor.

Whatever the form of organization, there is always a body of laws variously called the Sanitary Code, or the Public Health Law, which governs public health matters within that state. Broadly speaking, the various provisions of these laws show considerable uniformity in the different states. In many states, for example, the law relating to foods is practically identical with the Federal Food, Drug, and Cosmetic Act; many states have adopted the model milk law proposed by the United States Public Health Service; in dealing with the control of communicable diseases the standards set up by the American Public Health Association are finding general acceptance. Accordingly one finds the general character of the health programs quite similar throughout the nation as a whole. We may take pride in the fact that this has been achieved, not by the fiat of a dictator, but by voluntary action on the part of the individual states.

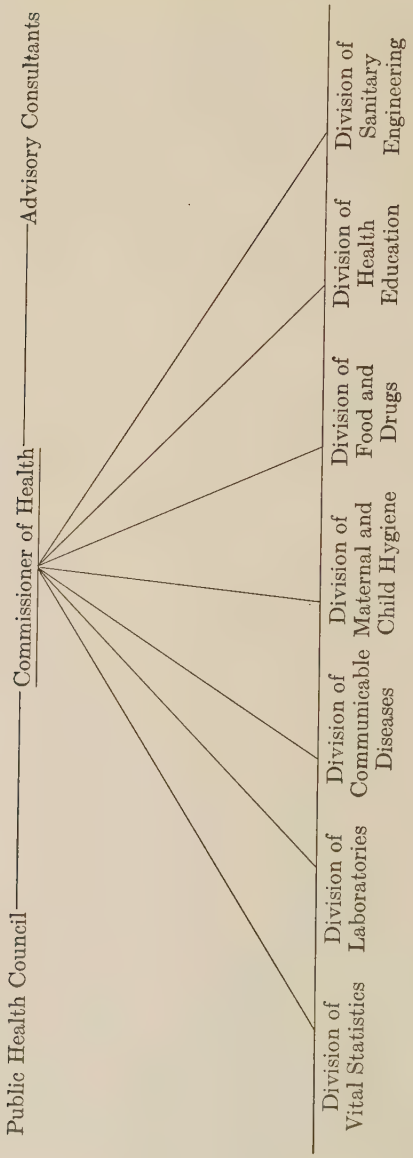
A number of different agencies have played an important part in promoting uniformity of procedure. The pioneer was the Division of Vital Statistics of the Bureau of the Census, which gradually brought about the enactment, by the individual states, of uniform laws for the registration of deaths and the adoption of a standard form of death certificate. Subsequently the same agency secured the adoption of uniform procedures for birth registration. The Public Health Service has contributed much through its annual Conference of State and Territorial Health Officers. The same is true of its demonstrations in rural sanitation and in county health administration. Perhaps the most important of all the factors has been the work of the health officials themselves through the Ameri-

can Public Health Association, which has dealt with the entire field of public health. Its annual conventions afford an opportunity for the interchange of experiences and views, its official organ, the Journal, and the annual Year Book, are important sources of information, and the various publications on "Standard Methods" are authoritative guides followed by practically all state health departments. Among other nonofficial agencies which have played a part in establishing uniformity of methods, mention should be made of the National Tuberculosis Association, the American Social Hygiene Association, the American Society for the Control of Cancer, the American Heart Association, and the National Safety Council.

With few exceptions the State Health Departments entrust most of the immediate local administration of health affairs to local health officers (county, town or village), confining their activities chiefly to supervision to see that the state law is being observed. A number of functions, however, are usually carried out directly by the state department, especially those relating to laboratory services, the care of the tuberculous, control of the milk supply and supervision of water supply and sewage disposal, and the collection and tabulation of vital statistics.

Subject to the qualifications discussed above, a typical state health department usually presents the organization shown in the diagram (page 320).

There is, however, still considerable variation in the degree of control which the State Health Department can and does exercise over the activities carried on by the various local health units. In some states, as was true in New York prior to 1914, the law gives the State Health Department very little real control. The situation, however, has greatly improved in recent years. Biggs met the situation in New York by gradually enacting regulations prescribing the qualifications of local health officers and others engaged in public health work. Additional control was secured by legislation which permitted state aid to local health units upon compliance with certain requirements. Still later, legislation gave the State Commissioner of Health disciplinary powers under specified conditions.


Public Health Council
Commissioner of Health
Advisory Consultants
Division of Vital Statistics
Division of Laboratories
Division of Communicable Diseases
Division of Maternal and Child Hygiene
Division of Food and Drugs
Division of Health Education
Division of Sanitary Engineering

LOCAL HEALTH ADMINISTRATION

So far as the local health officer is concerned, his responsibilities will embrace activities in the various categories shown in the organization of the State Health Department. Above all, he must be alert to improve health conditions in his community. It is unfortunate that in this country the public has not become sufficiently educated to appreciate the value of well-trained, full-time health administrators, especially for larger cities or groups of towns. Too often, still, the health officer is a political appointee without special training and devotes only part time to his work. In view of the

Fig. 87.—Dr. Charles V. Chapin (1856–1941).

salaries usually offered and the uncertain tenure of office the public can hardly expect to enlist devoted, expert, full-time service. In this respect our English cousins furnish an example which we might well copy. In England public health administration is a career, health officers enter it after special training, and efficiency determines the appointee's tenure of office and his advancement. Salaries are commensurate with the responsibilities and duties.

The attention devoted to the various health activities will vary depending on the character of the community, whether urban, suburban or rural; whether industrial, agricultural,

residential, etc. It will be influenced by the age composition of the population, by the availability of hospital and laboratory facilities, and above all by the funds which can be provided for the support of the health department. Just as a good housekeeper apportions her weekly allowance so that it will be most effective, so must the local health officer expend his budget so as to yield the greatest return to the taxpayers. The pioneer in this phase of health administration was my friend, Dr. Charles V. Chapin, for many years distinguished Superintendent of Health in Providence, R. I. The outgrowth of Chapin's work was the "appraisal form" now extensively adopted in this country for measuring the effectiveness of health administration. It has been of great value in modernizing current practices. Full information regarding the appraisal form can be obtained from the American Public Health Association.

It is generally agreed that adequate community health services require a budget for the Health Department on a basis of about $1 per capita of population. This does not include street cleaning or the removal and disposal of rubbish and garbage. Nor does it include hospital care. Carroll Fox gives the following examples of a minimum budget for a town of 10,000 population and for one of 25,000. In both cases this minimum budget amounts to an annual expenditure of 75 cents per capita of population.

Town of 10,000	
One health officer	$3,000
One public health nurse	1,200
One clerk	1,000
Salaries	$5,200
Maintenance	2,300
Total, all full time	$7,500

Town of 25,000	
One health officer	$3,500
One epidemiologist	2,500
Three public health nurses	3,600
One milk inspector	1,500
One sanitary inspector	1,200
One statistical clerk	1,200
One stenographer	1,000
Salaries	$14,500
Maintenance	4,250
Total, all full time	$18,750

The senior author believes that the health officer's salary in both these cases is too low. He would accordingly favor permitting the health officer to accept some suitable addi-

tional remunerative position, but not the private practice of medicine.

In the larger town the epidemiologist acts also as bacteriologist. Besides this he divides the duties of school inspector and clinic physician with the health officer.

For a city of 100,000 population Professor Ira V. Hiscock suggests $200,000 to $235,000 as necessary to provide adequate health service not including hospital care or removal of rubbish and garbage.

A survey of 1000 largest cities in the United States showed that in 1923 the average per capita expenditure by the health departments was 59 cents; in 1929* a survey of 92 of these cities showed an annual per capita expenditure of 76.6 cents. In other words the appropriations for health work in this country are generally far too low. The public has not yet learned that money spent for well-planned and well-directed health work yields very handsome dividends.

* Conditions since that time have been so abnormal that it is not possible to supply reliable figures for more recent years.

CHAPTER XLV

EPIDEMIOLOGY AND PUBLIC HEALTH

In the past the term "epidemiology" has usually been employed to denote the collection and analysis of data regarding the occurrence of a communicable disease in order to determine how and under what circumstances the disease is spread.

Progressive health authorities no longer limit the term to communicable diseases, and very properly speak of the epidemiology of diabetes, of pellagra, of gastric ulcer, and of many of the noncommunicable diseases. The change has come about largely because the methods of the epidemiologist have so often furnished valuable clues in the study of these other diseases, that they are now regarded as well-nigh indispensable in medical research.

Under the older, restricted conception, most health departments regarded the epidemiologist as a medical detective whose services were to be called upon mainly to help control some unduly prevalent infectious disease by tracing its source and mode of spread. In fact, such is still the prevailing practice. This is doubly unfortunate. In the first place, the communicable infectious diseases no longer play the major rôle in public health. Of far greater importance at the present time are the chronic degenerative diseases of later life and such conditions as diabetes, appendicitis, peptic ulcer, chronic arthritis, disorders of nutrition and the deficiency diseases. Secondly, the experienced and alert epidemiologist can contribute much to our knowledge of disease generally. Progressive health administrators will therefore regard the epidemiologist as one of their chief medical officers and give him ample facilities and resources to pursue his studies. They will not burden him with routine administrative work which can be handled by competent clerks.

The Ideal Epidemiologist.—The epidemiologist should, of course, be a physician and have had training in laboratory

work and in statistical methods. It is highly desirable that he maintain a hospital connection in order to keep himself constantly abreast of clinical medicine. Knowledge of a foreign language is an asset. To be successful the epidemiologist must have imagination and a strong leaning to curiosity. He will constantly be asking himself, Why? Why do epidemics of poliomyelitis come in summer? Why has scarlet fever mortality declined so markedly? Why does leprosy spread in certain parts of the world and not in others? Why is diabetes so much more prevalent among Jews? Why is diabetes mortality among married and widowed women over forty-five years nearly three times higher than it is among unmarried women of the same age? Why the higher incidence of peptic ulcer among males? The greater prevalence of gallbladder disease among females? The cyclic recurrence of measles, meningococcus meningitis and some other infectious diseases?

It is the constant search for answers to such questions that results in medical progress and in the more effective control of disease. At the present time epidemiologists having all the qualifications described above are not numerous. In most health departments the epidemiologist confines his attention to the communicable diseases. Accordingly, in the following pages we shall discuss epidemiology in its restricted sense.

EPIDEMIOLOGY IN ITS RESTRICTED SENSE

Source of the Original Data.—In most instances the basis for any epidemiologic study consists in reports of cases of the disease made to the health authorities. Such reports usually require the name and address of the patient, the age and sex, the name of the disease, and sometimes the date of onset. It is advisable not to ask for too much information in such reports, for physicians may regard this as irksome and consequently fail to report all cases of notifiable disease.

The health officer is at once in a position to note the prevalence and distribution of the cases, especially if he maintains a proper system of recording the information.

Chronologic Record.—For each notifiable disease a record of the cases reported should be kept chronologically, so that

one can determine at any time the number of cases reported week by week. In many of the more common communicable diseases it is most helpful to be able to compare the number of cases reported during a given period with the number in the corresponding period of other years. (See Endemic Index,

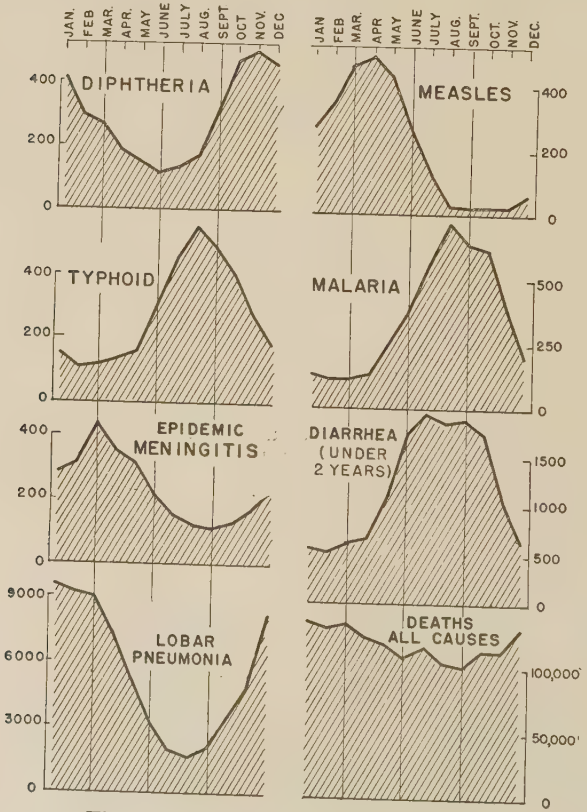


Fig. 88.—Seasonal incidence of disease.

discussed in the next chapter.) Such a comparison may at once indicate an undue prevalence of the disease and show the need of special investigations to ascertain the cause of this prevalence. The chronologic record has value also in discovering what influence *season* has on the occurrence of

some particular disease. For example, measles, scarlet fever, diphtheria, cerebrospinal meningitis, pneumonia and influenza are regularly far more prevalent in the winter and spring than in the warmer months. On the other hand, malaria, yellow fever, hay fever and poliomyelitis are more prevalent in warm weather and are rare or disappear entirely in cold weather. It is significant that the diseases first mentioned (those prevalent in winter) are almost all spread from person to person by means of infected discharges, while a number of warm-weather diseases are known to be spread by insects. In studying a new disease, therefore, one is always interested in learning whether it is especially prevalent in some particular season, for this information may furnish a clue to its mode of transmission.

Figure 88 shows the seasonal incidence of deaths in the United States (average of 1935 and 1936) for certain important diseases, and for all causes of death. In individual cities there will be some deviation from that shown in the graph, because of geographic location. In New York City, for example, the peak of the diphtheria curve comes in January or February, the low point in August. The general shape of the curve, however, is the same as in the graph.

Geographic Record.—Hand in hand with the chronologic record, it is advisable to maintain a system of records showing the location of diseases reported. This is conveniently done by means of pin maps. For this purpose one should use large-scale maps in which all the streets are clearly shown. It is advisable to use a separate map for each disease, though by means of different colored pins one can indicate different types of cases. Such a map will frequently bring to light some unusual grouping of cases demanding special attention. In studying diseases which may be water-borne—typhoid fever, for example—it may be helpful to indicate on the map the area having different water supplies. If on such a map one found a marked grouping of cases in the area having some special water supply, one would naturally make a very careful study of the possible relation between the water supply and the cases of the disease. (See Fig. 89.)

Case Studies.—The reports made by the physician to the health officer hardly permit of more study than the chrono-

logic and geographic distribution as just described, and such study, after all, is only preliminary to a real epidemiologic investigation. In reports of the less familiar diseases and conditions and in all important diseases in which the spread of the disease is obscure, the investigation should be made by an experienced epidemiologist who will recognize significant clues and know how to follow them. In the routine investiga-

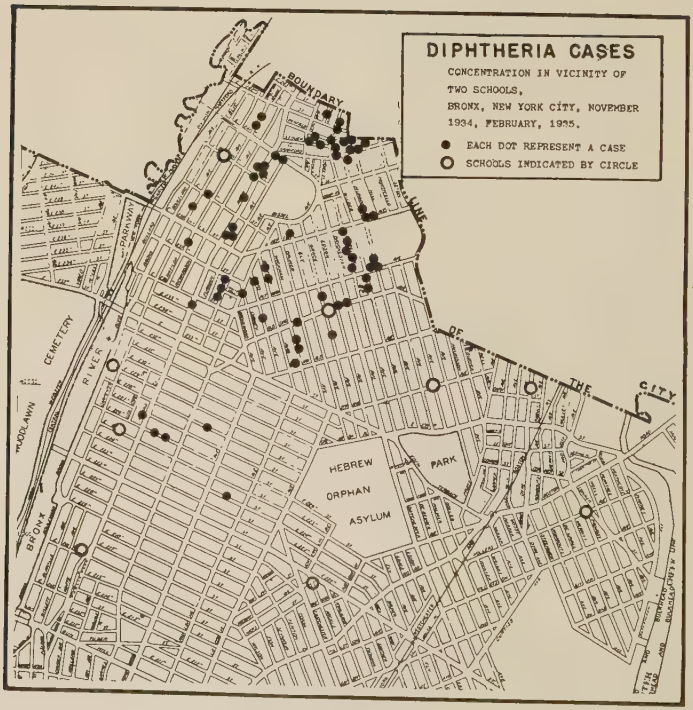


Fig. 89.—A typical spot map.

tions of the commoner infections it is customary to send a public health nurse to visit each case reported and require her to fill out a card giving detailed information regarding the case. So much depends on the careful, intelligent and complete filling out of this case record that a consideration of the information usually needed and its significance may be profitable.

General Data.—Following the patient's name and address the card should include spaces for age, sex, color, nationality and occupation.

Age is always an important epidemiologic fact. Diphtheria, measles, chickenpox and scarlet fever usually attack young children; poliomyelitis and cerebrospinal meningitis mostly children, but also adults; epidemic encephalitis mostly adults, but also children; typhoid fever mostly adults. Cases reported as chickenpox among adults deserve special investigation to make sure they are not smallpox. The age grouping of a series of cases may sometimes furnish a clue to the source of infection. Thus, outbreaks of typhoid fever, in which a large proportion of the cases are in children, will usually be found to be milk-borne, for children are the largest consumers of milk.

Color is asked in order to learn whether the cases are among whites or Negroes or Asiatics.

Nationality aims to discover whether the occurrence of the disease is in any way connected with habits peculiar to certain nationalities (*e. g.*, trichinosis occurs frequently among Germans who eat uncooked ham).

Occupation is an important item for two reasons: (1) certain communicable diseases, such as anthrax, tuberculosis and hookworm, may represent a distinct hazard of the industry; (2) communicable diseases, such as those occurring, for example, among food handlers, may demand special control measures to prevent the spread of the disease to others, even after the patient has convalesced. This subject is also discussed in Chapter III.

Home Conditions.—Information should also be obtained regarding the home, especially its sanitary features, the number and size of the rooms, the character of the neighborhood, the proximity of stables, swamps and outdoor privies, and the presence of flies, mosquitoes, bedbugs, roaches, lice and other vermin. Some of this information is needed in order to discover the possible source of infection, or the manner of its spread. Other items are important in order to decide whether home isolation can be permitted.

The Family.—The data regarding the family should give the number of children, number of adults, boarders and servants. Careful inquiry should be made to ascertain

whether any of these have or have had the disease under consideration, or symptoms which may have been due to a mild, atypical attack of the disease. In diseases like typhoid fever one should carefully question the person or persons who cook the food for the family, and any servant who may have handled food, in order to learn whether at any time, even years ago, such a person had an illness accompanied by fever which may have been typhoid fever, or whether anyone in the family has ever been in contact with a case of the disease in question. Carriers may sometimes be discovered in this way.

The Patient.—Coming now to the patient and his illness, it is important first of all to secure accurate information regarding the date of onset of the disease. In most of the acute communicable diseases this presents little difficulty, though it is well for the investigator to be familiar with the symptoms associated with the onset of the more important communicable diseases. If the date of onset can be determined fairly well, it constitutes the point from which one counts the number of days of the average incubation period in order to arrive at the approximate date on which infection occurred. What the patient did at *this critical period,* where he visited, what he ate and drank, with whom he came into contact, are facts of the utmost importance. Under the circumstances it may be appropriate at this point to give a list of the *incubation periods* of some of the more common communicable diseases.

In connection with the inquiries regarding the patient's mode of life at about the time infection must have occurred, one should consider how the disease is most commonly transmitted. In diseases transmitted by food and drink, for example typhoid fever, detailed information should be obtained regarding the source of the water supply and the milk supply, and whether the milk was purchased loose or bottled, and whether it was raw or pasteurized. Ice cream should also be considered, and if it has been taken during the probable period of infection its source should be noted. The fact that shellfish, such as oysters, clams and mussels, were eaten is of importance and should be inquired into, as should also the eating of uncooked vegetables, such as lettuce, celery and

INCUBATION PERIODS OF COMMON COMMUNICABLE DISEASES

Disease.	Usual period of incubation.	Chief vehicle or mode of transmission.
Measles.....	8 to 12 days to the catarrhal symptoms. 11 to 14 days to the eruption.	Discharges of the nose and throat.
Scarlet fever...	2 to 7 days.	Discharges of nose and throat. Occasionally infected milk.
Diphtheria....	2 to 5 days.	Same as preceding.
Smallpox.....	Usually 8 to 12 days.	Material from the pustules.
Chickenpox....	10 to 15 days.	Material from the vesicles.
Typhoid fever..	10 to 14 days.	Stools and urine of patient.
Malaria.....	36 hours to 2 weeks.	Infected Anopheles mosquitoes.
Yellow fever...	3 to 6 days.	Infected Aëdes mosquitoes.
Epidemic meningitis...	Uncertain.	Discharges of nose and throat.
Poliomyelitis...	Uncertain.	Probably nasal discharges. Perhaps intestinal excreta.
Typhus fever..	8 to 12 days.	Lice; sometimes fleas.

watercress. In diseases carried by insects the life history of the responsible species must be borne in mind. In malaria one should note when and where the individual has been exposed to the bites of Anopheles mosquitoes; in typhus one should consider the possible presence of lice; in plague, of fleas from infested rodents.

Primary and Secondary Cases.—In attempting to trace a connection between a group of cases, and to discover, if possible, the source of infection, it is important to classify the cases according to their *date of onset.* In this way one can often distinguish immediately a primary group of cases which must have received their infection from the same source. If one is seeking the original source of infection it is advisable to concentrate attention on this primary group. In longer continued outbreaks it is most important to discover why the cases continue, and in such instances careful study of the later cases will also be necessary.

Other Uses of Case Records.—Inasmuch as the information supplied by the nurse on the case cards is used not merely for purposes of tracing the source of contagion, but also for purposes of exercising supervision and control of the disease, data regarding the management of the case, the effectiveness

of isolation, the observance of necessary precautions, and the like must also be obtained.

Importance of Case Records.—One cannot insist too strongly on the answering of *every question on a case card.* The lack of one or more answers on any considerable number of cards may make the analysis of the data worthless. Thus, if data are asked concerning a servant, and no servant is kept, the card should state "no servant." If there are children in the family, but not living at home, the card should state this fact. If little or no information can be obtained because of failure to understand the language, it is wise to report that fact on the card so that the health officer may perhaps have the case revisited by someone who speaks the language. Case cards are very important epidemiologic records, and the greatest care should be taken to have them both complete and accurate.

CHAPTER XLVI

THE ENDEMIC INDEX

HEALTH administrators are naturally concerned with the detection of any unusual prevalence of disease in their community. For this reason the alert health officer keeps constant watch of the community's vital statistics. However, in order to determine whether there is any undue prevalence of a disease, it is important that he has at hand information regarding the usual prevalence of that disease. In other words, he must know the *endemic index* of the disease or the condition.

To determine the endemic index one tabulates the data for the preceding six or seven years, preferably by weeks, but at least by months, and then studies the figures to see whether or not they are fairly uniform. One may take the *average* of the given week's figures, but if in one of the years there has been a particularly large number of cases for the week, this average will be too high to reflect the usual condition for the week in question. For this reason many epidemiologists employ the *median* instead of the average. In order to determine the median, one arranges the figures in order, from the lowest to the highest. The middle one of the series is the median. In calculating the average, one adds the figures and divides by the number of items. The following comparison may be of interest:

Cases in the Forty-third Week

1934	38
1935	68
1936	30
1937	35
1938	33
1939	35
1940	41
7-year total	280
Average	40

If we arrange the figures in order, from the lowest to the highest we have the following array:

30 33 35 35 38 41 68

The middle term of this array is the median, hence in this series it is 35. It will at once be seen that this gives a better picture of the usual condition during the week in question.

Bolduan in 1912 adopted a somewhat different plan to achieve a similar result. In the week's figures as presented above he would regard the 68 cases in 1935 as manifestly out of line. By omitting the 68 and then taking the average of the remaining six items he arrives at what he terms a *normalized average,* in this case 35.3. If, because of a known epidemic outbreak, two of the years should show specially high figures, both could be omitted or, preferably, for that particular week one could use the figure for the year before the first one of the series employed in the other calculations. Thus in the sixth week of the year the following cases are reported.

1934	16
1935	43
1936	12
1937	15
1938	39
1939	11
1940	18
7-year total	154
Average	22

It is evident that the figures for 1935 and 1938 are much out of line. If we drop both, we have five items left, the average of which is 14.4. The median of the seven items is 16, for this is the middle of the array:

11 12 15 16 18 39 43

In a case like this Bolduan prefers to calculate the "normalized average" by going back to 1933 and finding that the figure for the sixth week of that year was 12. Leaving out 1935 and 1938 he has a total of 84 cases for six years, a normalized average of 14.

Inasmuch as the purpose of establishing the usual normal

incidence is to detect any unusual prevalence of disease, *it is advisable to have the figures of this expected incidence as low as possible.*

In a disease like measles, which usually has very definite cycles of high and low prevalence, a further refinement is necessary. Thus in New York City we find the prevalence of measles from 1924 to 1930 inclusive to be as follows:

Reported Cases of Measles, New York City

1924	33,561
1925	9,843
1926	39,750
1927	2,101
1928	35,008
1929	2,537
1930	23,635
7-year total	146,435
Average	20,919

It is obvious that neither the average, 20,919, nor the median, 23,635, gives a picture of the usual prevalence of measles. Here it is manifestly advisable to calculate *separately* the usual incidence in high measles years and in low measles years. In this case we could go back to 1923 and include 13,999 cases reported during that year. Then we would have four high and four low years, as follows:

High		*Low*	
1924	33,561	1923	13,999
1926	39,750	1925	9,843
1928	25,008	1927	2,101
1930	23,635	1929	2,537
4-year total	131,954	4-year total	28,480
Average	32,988	Average	7,120

In the example here cited we have presented figures for the entire years. It will, of course, be understood that similar considerations apply to the calculation of the usual expectancy for individual weeks or months.

As in measles, so in other diseases marked by cycles of high and low prevalence. Reference to the graph showing the cyclic recurrence of epidemic meningitis (see Fig. 90) will indicate the advisability of calculating the usual prevalence

of this disease on the experience of nonepidemic years. Only in this way can epidemic outbreaks be quickly detected.

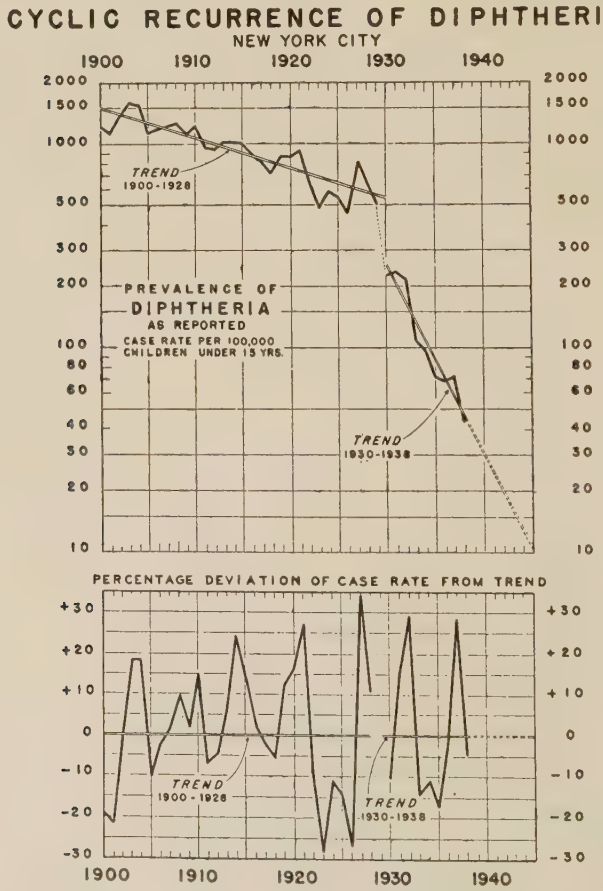


Fig. 90.—Detecting cyclic recurrence by calculating the percentage deviation from the trend.

Cyclic Recurrence.—In using the endemic index as a norm by means of which any unusual prevalence of a disease may be detected, the health administrator should also be familiar with the cycles of high and low prevalence of the disease as

they have manifested themselves in the past. In many cases these cycles are readily recognized from a simple graph plotting the course of the disease over a period of years as is shown in Fig. 63 in the case of epidemic meningitis. In other cases, especially where there is a marked downward (or upward) trend in the course of the disease, such cycles are not at once apparent. They become so, however, when a curve

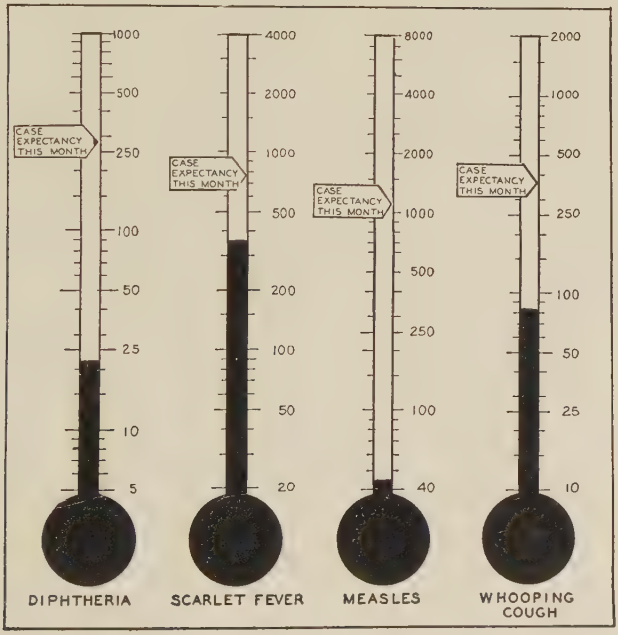


Fig. 91.—Section of "pathometer."

is plotted showing the *percentage deviation from the trend.* This is well brought out by the accompanying graph (Fig. 90), showing the cyclic recurrence of diphtheria in New York City. Armed with the information revealed by the lower part of this graph, the health officer will not be unduly alarmed should the current prevalence of the disease exceed somewhat the normal expectancy as measured by the endemic index, provided the current period occurs at a time when a cycle of

increased prevalence is about due. On the other hand, it will keep him from being too ready to claim credit for achievements, and too complacent, if he finds that a low current prevalence of the disease corresponds to an expected low in cyclic recurrence.

Pathometer.—To facilitate a continuous comparison of the current prevalence of disease with the endemic index, Olesen, of the United States Public Health Service, devised what he calls a "pathometer." This is a simple contrivance which any mechanic can easily construct. A section of such a pathometer as it is used in the New York City Health Department, is shown in Fig. 91. It consists, essentially, of a large framed cardboard showing the ten or twelve major infectious diseases. The space comparable to the tube of the thermometer is cut out, and behind this is a piece of tape, part white, part colored, so fixed by rollers above and below that it can be moved up and down. At the beginning of each month the tape is so adjusted that the seam between the upper white portion and the lower colored portion is at zero. Each day, as cases of the disease are reported, the tape is rolled, so that the height of the colored portion indicates the total number of cases reported during the month up to that time. The movable indicator is adjusted each month to show the case expectancy (the endemic index) for that month.

CHAPTER XLVII

VITAL STATISTICS

Vital statistics has been called the bookkeeping of health. Guilfoy defined the term as "the numerical registration and tabulation of population, marriages, births, diseases, and deaths, coupled with analyses of the resulting numerical phenomena." The collection and correct analysis of vital statistics are absolutely indispensable to intelligent public health work. While it is true that certain intricate statistical analyses require a ready familiarity with higher mathematics, almost all of the problems commonly encountered in public health work can be subjected to statistical study by the use of very simple mathematical operations. This will become clear in the following pages.

Few other countries have done more than the United States to apply vital statistics to public health administration. Building on the foundation laid by Farr and developed by Bertillon, a host of Americans have gradually succeeded in making vital statistics the essential basis of administrative practice. Among these may be mentioned Elisha Harris, John Shaw Billings, William H. Guilfoy, Cressy L. Wilbur, William H. Davis, Louis I. Dublin, Haven Emerson, and J. V. DePorte. A wide and wholesome influence on the correct use of vital statistics has been that of the well-known textbooks by Farr and by Newsholme (both of London), by Whipple of Harvard, Chaddock of Columbia, and King of New York University.

Population Statistics.—An accurate knowledge of the number of people in the community, state or country is the very basis of vital statistics. This is obtained by counting, *i. e.*, by taking a *census* of the people. In the United States the Federal authorities take a census every ten years. Some of the states supplement this by taking a census of their own, usually midway between the Federal enumerations. The Federal census of 1930 showed a population in the continental

United States of 122,775,046, in 1940 it was 131,409,000.* When one speaks of the population, one usually means the population of July 1st, *i. e.*, in the middle of the year.

In studying health problems it is not sufficient, however, to know the population every ten years; we need to know what the population is from year to year. Since the taking of a yearly census is impracticable, statisticians make use of calculations to estimate what the population in any given year may be. They take the population as given by the latest two censuses and find out what the increase was in that period. If the censuses are ten years apart, they divide this increase by ten and say that the population increased in each year by the amount found by this division. They then assume that the population increased by the same number each year since the last census, and so arrive at the estimated population for the year in question. This method, which is widely in use, is spoken of as the *arithmetical* method of estimating the population. Thus, taking the Federal censuses 1910 and 1920, the population of the City of New York in the years 1921 to 1927 is estimated as follows:

New York's population at 1920 census..... 5,663,980
New York's population at 1910 census..... 4,785,190

The increase in ten years was..... 878,790 or 87,879 per year

In 1920 the population was 5,663,980

Therefore the *estimated* population in

1921 was 5,663,980 + 87,879 = 5,751,859
1922 was 5,751,859 + 87,879 = 5,839,738
1923 was 5,839,738 + 87,879 = 5,927,617
1924 was 5,927,617 + 87,879 = 6,015,496
1925 was 6,015,496 + 87,879 = 6,103,375
1926 was 6,103,375 + 87,879 = 6,191,254
1927 was 6,191,254 + 87,879 = 6,279,133

Populations do not remain stationary; their number is increased by births and decreased by deaths. The difference between the births and the deaths gives the *natural increase* in the population. Countries like the United States have added to their population also by immigration. Other countries are losing from their population by emigration.

* Preliminary official figure.

It is not enough to know merely the entire number of persons in a community, state or nation. We must also know the number of males and females, the number of single and married, the number of whites and Negroes, and we need to know something about their ages. As a matter of fact, these and other data concerning the population are collected and tabulated by the census.

Marriage Statistics.—In the study of a number of health problems we need to know the number of marriages performed year by year. Such statistics are therefore compiled by the responsible registrar and furnished to the health authorities. In many states, reports of marriages must be filed directly with the Department of Health.

Birth Statistics.—Accurate birth statistics are extremely important in public health work, yet at present some parts of the United States fail to provide for a complete registration of their births. In the year 1915 the United States Bureau of the Census established what is called the "Birth Registration Area," comprising those states in which the registration of births was fairly complete. At the time the area embraced only ten states and the District of Columbia. Through the efforts of the Census Bureau many other states have been admitted, until now it includes the entire population of the United States. The analyses of the birth statistics of the Birth Registration Area are most valuable and permit fairly accurate comparisons between the statistics of different states.

Birth rates may be expressed as the number of births per 1000 of population, or as the number per 1000 women of child-bearing age. While the latter method is, of course, more accurate, the former is the one more commonly employed.

The registration of births is very important, for transcripts of such records are required for many different purposes (*e. g.*, settling estates, in proving a child's parentage and legitimacy, to secure a child's admission to school, to show whether a person has attained majority, or whether a girl has reached the age of consent, to establish age in connection with pensions, military duty, voting, etc.).

Morbidity Statistics.—It is unfortunate that the collection and analysis of morbidity statistics has been so little

developed anywhere. To a large extent the failure to utilize morbidity statistics to any worth-while degree has been due to the lack of standard classification or nomenclature comparable to the International Classification of the Causes of Death. Through the work of a committee of the Welfare Council, City of New York, we now have available a satisfactory list, embracing about six hundred titles, which has shown itself well adapted to meet the requirements. With this at hand, hospital morbidity statistics can now be collected and tabulated according to the simple plan proposed by Bolduan in 1913.* That the plan is practicable and that it yields valuable information has recently been demonstrated by the successful collection of morbidity statistics embracing over 500,000 patients treated in 110 hospitals in New York City during 1933. Under the circumstances this plan should now become an established procedure.

In most countries the collection of morbidity statistics, *i. e.*, statistics regarding the occurrence of disease, is now undertaken chiefly as part of the plan to control communicable diseases and other preventable conditions. The basic data are obtained by enforcing the reporting of such diseases and conditions to the authorities. At present, health authorities in the United States usually require the following to be reported, though the lists differ somewhat in different states:

Anthrax.
Chancroid.
Chickenpox.
Cholera.
Diphtheria.
Dysentery.
Epidemic meningitis.
German measles.
Glanders.
Gonorrhea.
Hookworm.
Leprosy.
Malaria.
Measles.
Mumps.
Ophthalmia neonatorum.
Paratyphoid fever.
Pellagra.
Plague.
Pneumonia.
Poliomyelitis.
Psittacosis.
Puerperal septicemia.
Rabies.
Scarlet fever.
Septic sore throat.
Smallpox.
Syphilis.

* "Hospital Morbidity Statistics"; Charles F. Bolduan, Reprint Series No. 9, New York City Department of Health, 1913; Second printing, 1934.

Tetanus.
Trachoma.
Tuberculosis.
Tularemia.
Typhoid fever.
Typhus fever.
Undulant fever.
Whooping cough.
Yellow fever.

In some states industrial poisoning and accidents are also reportable, though not always to the health authorities. The more important reportable industrial diseases and accidents are poisoning with arsenic, lead, mercury, or phosphorus, caisson disease and silicosis.

The information obtained from the reports made concerning the occurrence of one of the reportable diseases is used in many instances to insure the isolation of the patient and the observance of precautions to prevent spreading the disease to others. It is also used extensively in epidemiologic investigations to discover the source of infection, the way in which the disease is transmitted, and the value of some particular procedure in dealing with the disease.

It is the practice of most health authorities to have nurses (sometimes trained medical inspectors) visit all persons reported ill with certain of the reportable diseases, in order not only to see to the observance of necessary precautions, but also to secure detailed information concerning the case.

In publishing statistics concerning the occurrence of disease, one expresses the morbidity in rates giving the number of cases per 100,000 of the population. Diseases limited principally to certain ages or to certain classes of the population should be expressed also in rates showing the number in, say, 1000 persons of that age or class. Diseases limited to women should be expressed in rates per 1000 women.

Mortality statistics are statistics of death. They are of great value to the public health administrator, especially when they are tabulated to show the causes of death arranged by age, sex, nativity, occupation, racial distribution, season, etc.

In the absence of accurate morbidity statistics they serve also as an index of the prevalence of certain diseases, but, so used, mortality statistics constitute only an imperfect guide.

Death Certificates.—The basic data for mortality statistics are the reports of the death made by the physician who at-

tended the patient during his last illness. Throughout the United States the law provides that the body of the deceased person may not be buried, cremated, shipped or otherwise disposed of without a permit from the proper authorities, usually the local health officer or registrar of vital statistics.

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

STANDARD CERTIFICATE OF DEATH

State File No. _____
Registrar's No. _____

State of _____

1. PLACE OF DEATH:
(a) County _____
(b) City or town _____ (If outside city or town limits, write RURAL)
(c) Name of hospital or institution: _____ (If not in hospital or institution, write street number or location)
(d) Length of stay: In hospital or institution _____ (Specify whether years, months or days)
In this community _____

2. USUAL RESIDENCE OF DEATH:
(a) State _____ (b) County _____
(c) City or town _____ (If outside city or town limits, write RURAL)
(d) Street No. _____ (If rural give location)
(e) If foreign born, how long in U. S. A.? _____ years.

3(a) FULL NAME _____
3 (b) If veteran, name war _____
3 (c) Social Security No. _____
4. Sex _____
5. Color or race _____
6(a) Single, widowed, married, divorced _____
6 (b) Name of husband or wife _____
6 (c) Age of husband or wife if alive _____ years
7. Birth date of deceased _____ (Month) (Day) (Year)
8 AGE: Years | Months | Days | If less than one day _____ hr. _____ min.
9. Birthplace _____ (City, town, or county) (State or foreign country)
10. Usual occupation _____
11. Industry or business _____
MOTHER FATHER
12. Name _____
13. Birthplace _____ (City, town, or county) (State or foreign country)
14. Maiden name _____
15. Birthplace _____ (City, town, or county) (State or foreign country)
16 (a) Informant's own signature _____
(b) Address _____
17 (a) _____ (Burial, cremation, or removal) (b) Date thereof _____ (Month) (Day) (Year)
(c) Place; burial or cremation _____
18 (a) Signature of funeral director _____
(b) Address _____
19 (a) _____ (Date received local registrar) (b) _____ (Registrar's signature)

MEDICAL CERTIFICATION

20. Date of death: Month _____ day _____ year _____ hour _____ minute _____
21. I hereby certify that I attended the deceased from _____, 19___, to _____, 19___; that I last saw h___ alive on _____, 19___; and that death occurred on the date and hour stated above.

	Duration
Immediate cause of death _____	
_____	
_____	
Due to _____	
_____	
Due to _____	
_____	
Other conditions (Include pregnancy within 3 months of death) _____	
Major findings:	
Of operations _____	
_____	
Of autopsy _____	
_____	

PHYSICIAN
Underline the cause to which death should be charged statistically.

22. If death was due to external causes, fill in the following:
(a) Accident, suicide, or homicide (specify) _____
(b) Date of occurrence _____
(c) Where did injury occur? _____ (City or town) (County) (State)
(d) Did injury occur in or about home, on farm, in industrial place, in public place? _____ (Specify type of place)
While at work? _____ (e) Means of injury _____
23. Signature _____ (M. D. or other)
Address _____ Date signed _____

Fig. 92.—Standard form of death certificate used in the United States.

This law is everywhere so strictly enforced that the registration of deaths throughout the United States is quite complete.

The standard death certificate, which must be filed with the local authorities, provides for answers to a number

of important questions, *e. g.*, name of deceased, age, sex, color, date and place of birth, occupation, name and birthplace of decedent's father, maiden name and birthplace of mother; date and time of death, cause of death, duration of illness, place of death, whether at home or in a hospital, hotel, etc. The certificate must be signed by the physician and also by the undertaker. The latter fills in the date and the intended place of burial.

Official *transcripts* of death certificates are required for a number of purposes, such as the settlement of estates and the collection of life insurance. In transcripts of the standard certificate now in general use, the information regarding the cause of death is thus made accessible to many individuals. Under these circumstances physicians may be led not to record the true cause of death in cases of syphilis, alcoholism, abortion, tuberculosis or cancer, fearing displeasure on the part of the decedent's family. In order to meet the situation, Switzerland has long made use of a certificate consisting of two parts, one giving the facts regarding the identity of the deceased and the date and place of death, the other a confidential statement by the medical attendant as to the cause of death. Official transcripts are furnished only of the first part.

Some years ago the health department of Westchester County, New York, made a trial of *confidential certification* and found that there resulted a more accurate reporting of certain causes of death. In New York City, Duffield has recently introduced confidential certification as an experiment, and his experience so far is similar.

Study of Mortality Statistics.—In analyzing mortality statistics it is important to bear in mind that the basic data are not free from error, especially as to the cause of death. The diagnosis of disease is far from perfect, and clinical diagnoses which do not agree with autopsy findings occur even in our best hospitals. Some years ago Cabot made a careful study of this subject by comparing the clinical diagnosis with the autopsy findings in 3000 cases treated in certain Boston hospitals. The percentage of correct diagnosis, as shown by autopsy, was, in part, as follows:

	Per cent.
In Diabetes mellitus	95
Typhoid fever	92
Aortic regurgitation	84
Cancer of the colon	74
Lobar pneumonia	74
Cerebral tumor	73
Tuberculous meningitis	72
Cancer of the stomach	72
Brain hemorrhage	67
Septic meningitis	64
Active tuberculosis	59
Thoracic aneurysm	50
Cirrhosis of the liver	39
Gastric ulcer	36
Bronchopneumonia	33
Chronic myocarditis	22
Abscess of the liver	20
Acute nephritis	16

In spite of this source of error, mortality statistics properly analyzed yield a great deal of information regarding disease, for one can often deal with groups of diseases and draw valid conclusions regarding the group as a whole which would not hold for each of the individual causes of death.

General Death Rates.—The term "general death rate" is applied to the number of deaths from all causes per 1000 of the population.

Many students have difficulty in calculating birth and death rates. The matter is really very simple and easily understood. For example in New York City in 1930 the population was 6,962,305. The total number of deaths was 74,888. What was the general death rate per 1000 of population?

Obviously we should first determine how many thousands there are in the population. Dividing 6,962,305 by 1000 we find that there were 6962 groups of a thousand each. If, now among these 6962 groups there were 74,888 deaths, how many deaths were there for a single group? This is a matter of simple division, comparable in every way to the familiar elementary school example of 60 boys dividing 120 apples.

6962) 74,888.00 (10.76

In other words there were 10.76 deaths per 1000 of population.

It is customary when dealing with individual diseases to express the rates per 100,000 instead of per 1000. In this way

one often avoids using decimals. For example, in New York city, there were 22 deaths of typhoid fever in 1939. This is at the rate of 0.3 per 100,000 of population. That is already a decimal figure. If the rate were expressed per 1000 it would be still more awkward, namely 0.003! The city's death rate of pulmonary tuberculosis was 46 per 100,000, a whole number; expressed per 1000 of population it would be 0.46, a less convenient decimal.

The general death rates of some of the larger American cities in 1939 are shown in the following table:

VITAL STATISTICS—26 LARGE AMERICAN CITIES—1939

City.	Estimated population.	Live births.		Deaths.		Infant mortality.			
						Under 1 year.		Under 1 month.	
		No.	Rate. (2)	No.	Rate. (2)	No.	Rate. (4)	No.	Rate. (4)
New York	7,347,000	102,261	13.9	75,439	10.3	3,793	37.1	2,533	24.8
Chicago	3,383,744	48,909	14.5	35,931	10.6	1,533	31.3	1,068	21.8
Philadelphia	1,936,674	30,232	15.6	24,247	12.5	1,299	43 0	866	28.6
Detroit	1,613,560	28,100	17.4	13,227	8.2	1,119	39.8	773	27.5
Los Angeles	1,465,125	15,741	10.7	13,855	9.5	624	39.6	442	28.1
Cleveland	951,400	12,574	13.2	9,849	10.4	572	45.5	400	31.8
Baltimore	849,217	12,525	14.7	10,386	12.2	511	40.8	300	24.0
St. Louis	814,569	14,275	17.5	10,692	13.1	506	35.4	332	23.3
Boston	811,816	16,097	19.8	11,146	13.7	677	42.1	453	28.1
San Francisco	693,000	8,817	12.7	8,746	12.6	256	29.0	180	20.4
Pittsburgh	665,827	10,074	15.1	6,856	10.3	462	45.9	293	29.1
Washington, D. C.	627,000	13,981	22.3	8,437	13.5	671	48.0	446	31.9
Milwaukee	588,427	9,216	15.7	5,681	9.7	355	38.5	255	27.7
New Orleans	488,930	10,806	22.1	7,823	16.0	746	69.0	(1)	.....
Minneapolis	487,409	9,147	18.8	5,410	11.1	310	33.9	226	24.7
Cincinnati	452,683	8,781	19.4	6,717	14.8	375	42.7	262	29.8
Newark	429,646	7,950	18.5	5,005	11.6	303	38.1	193	24.3
Kansas City, Mo.	400,132	6,513	16.3	4,994	12.5	287	44.1	201	30.9
Indianapolis	372,100	6,725	18.1	5,418	14.6	324	48.2	197	29.3
Houston	367,450	8,240	22.4	4,244	11.5	435	52.8	273	33.1
Louisville	351,500	5,490	15.6	3,851	11.0	282	51.4	192	35.0
Columbus, Ohio	338,868	5,732	16.9	4,479	13.2	318	55.5	195	34.0
Jersey City	338,283	4,176	12.3	3,643	10.8	226	54.1	150	35.9
Portland, Ore.	337,183	5,300	15.7	4,024	11.9	181	34.2	126	23.8
Toledo	311,451	5,040	16.2	3,646	11.7	220	43.7	144	28.6
Denver	310,000	6,436	20.8	4,368	14.1	296	46.0	184	28.6
Totals	26,732,994	413,138	15.5	298,114	11.2	16,673	40.4	10,684	25.9

(1) Not available.
(2) Per 1000 population.
(4) Per 1000 live births.

From such a table one must not conclude that the relative healthfulness of the different cities can at once be determined by comparing the general death rate. Before we can make any such comparisons we must at least know something about the age, sex and race of the population of those cities. Let us see why this is necessary.

In the United States Registration Area in 1924 there were 1,081,805 deaths, and the population was 90,910,870. The general death rate, therefore was 11.90 per 1000. Analyzing the deaths according to *age*, and comparing the deaths in each age group with the number of persons of this age group in the population as a whole, we find the following:

			Per 1000 at this age.
Deaths under 1 year	147,677	or	82.3
1–4 years	53,032	or	6.8
Total under 5 years	200,709	or	21.0
5– 9 years	21,014	or	2.2
10–14 years	16,197	or	1.8
15–19 years	26,141	or	3.5
20–24 years	34,619	or	4.6
25–34 years	72,782	or	4.9
35–44 years	91,012	or	7.2
45–54 years	115,074	or	11.9
55–64 years	145,343	or	23.6
65–74 years	174,333	or	54.9
75 and over	183,196	or	133.3
Unknown age	1,385		

It will be noted that the death rate is very high in the very young and the very old. The mortality is least in the age period ten to fourteen years.

There has been a steady decline in the age-specific death rates during the past fifty years. The improvement has been greatest in infancy, childhood and early adult life, but even in the higher age groups there has also been some decline in the death rates. This can be seen from the table (p. 349) showing the specific death rates in New York City over a period of thirty years.

Because the death rates are high in infancy and in the aged, it is clear that if a community contains a very large proportion of very young or very old individuals, the number of deaths in the community will be high. On the other hand,

SPECIFIC DEATH RATES, NEW YORK CITY, 1900–1930, INCLUSIVE

Age.	1901-'02-'03.		1909-'10-'11.		1919-'20.*		1929-'30-'31.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
0– 4	60.3	52.6	50.2	43.2	32.4	26.5	19.4	15.4
5– 9	5.8	5.2	4.2	3.9	3.8	3.1	2.5	2.0
10–14	2.8	2.8	2.4	2.3	2.4	2.2	1.7	1.3
15–19	4.8	4.1	3.9	3.1	4.0	3.7	2.6	2.2
20–24	7.3	6.0	5.3	4.6	5.8	5.4	3.4	3.2
25–29	9.5	8.2	6.9	5.9	6.5	6.9	3.8	3.4
30–34	12.6	9.8	9.6	7.6	7.7	7.0	5.1	4.1
35–39	15.1	11.6	13.0	9.3	9.2	7.3	7.0	5.0
40–44	19.0	13.2	16.5	11.2	10.9	9.0	10.1	6.9
45–49	22.0	15.0	20.8	14.3	15.2	12.1	14.8	10.5
50–54	29.2	22.8	26.5	19.1	20.6	16.3	22.0	15.0
55–59	38.8	31.4	37.0	28.8	30.1	24.8	32.0	23.4
60–64	51.4	43.8	51.4	44.1	40.8	33.8	44.7	35.3
65–69	69.9	60.5	68.5	58.9	60.1	55.0	62.0	50.2
70–74	95.8	85.2	89.6	81.2	85.1	79.5	84.3	73.3
75–79	141.0	119.3	127.3	114.4	116.2	107.6	120.7	109.2
80–84	175.9	157.9	167.4	159.6	162.6	143.6	170.9	151.2
85 & Over	252.3	223.0	257.4	232.3	224.8	210.2	242.8	227.5

* As census date is the midpoint of the period presented, only two years are used for 1919-'20 calculation, the census having been made on Jan. 1, 1920.

the opposite condition, where a very large majority are young adults, may be met with. For example, during the building of the Panama Canal the population of the Canal Zone was so constituted. Naturally its general death rate was bound to be low.

In order to make comparisons of the death rates of communities, states or nations, one must make approximate corrections of the death rate to allow at least for the different age constitution of the populations. The simplest plan to arrive at such *corrected death rates* is to apply all the specific death rates to the same standard population. For convenience, statisticians often take as their standard the population of England and Wales in 1901, or the "standard million," as represented by the age constitution of Sweden at the census of 1890. We may study the following simple example to show what an influence the age composition of the population has on the death rates. Suppose the cities A and B have exactly the same specific death rates at the four specified age groups in the table, and exactly the same total population, but with dissimilar age groups. Let us then calculate the number of

deaths thus obtained and so arrive at the death rate in the two cities.

Population.	A.	Death rate per 1000.	Number of deaths.	B.	Death rate per 1000.	Number of deaths.
Under 1 year.....	1,500	100	150	1,000	100	100
1 to 19 years....	20,000	20	400	20,000	20	400
20 to 49 years....	15,000	15	225	20,000	15	300
50 years and over	13,500	60	810	9,000	60	540
Total.....	50,000		1585	50,000		1340

Crude general death rate: A = 31.70; B = 26.80.

It is thus seen that merely through a different age composition of their populations these two cities have crude general death rates which differ by 4.9 per 1000.

In making comparisons, therefore, one ought always to correct at least for the age composition of the population.

We may therefore define the corrected or standardized death rate as the rate which would have prevailed in the standard population if the specific death rates in its several age groups had been the same as those in the corresponding age groups of the population under consideration.

Even such corrected death rates must be used with caution when attempting to measure the comparative healthfulness of different communities, for they take into account only the age constitution of the communities and leave untouched such important factors as race, occupation and economic conditions. Many health officers therefore employ the *infant mortality* as a standard of comparison, for this is readily calculated and quite reliable provided the reporting of births is almost complete in the communities whose rates are compared.

Life Tables.—The average expectancy of life at different ages is another useful index of health conditions. As usually prepared in what is termed a "life table," this gives the aver-

ABRIDGED LIFE TABLE FOR NEW YORK CITY, 1805–1808 AND 1929–1931

Age interval.	Of 100,000 alive at age 10.*		Rate of mortality per 1000.	Expectation of life.
Period of life time between two exact ages.	No. alive at beginning of age interval.	No. dying in age interval.	No. dying in age interval among 1000 alive at beginning of age interval.	Average length of life remaining to each one alive at beginning of age interval.
x to $x+10$	l_x	d_x	1000 q_x	e_x
Years.			Annual rate.	Years.
Period 1805–1808				
10–19	100,000	6,582	65.82	37.64
20–29	93,418	15,099	161.63	29.84
30–39	78,319	17,726	226.34	24.57
40–49	60,593	15,791	260.61	20.28
50–59	44,802	15,012	335.08	15.70
60–69	29,790	14,872	499.23	11.10
70–79	14,918	10,820	725.29	7.30
80–89	4,098	3,810	929.61	4.48
90–99	288	282	980.37	2.66
100–109	6	6	1000.00	2.50
Period 1929–1931				
10–19	100,000	1,834	18.34	53.59
20–29	98,166	3,263	33.24	44.48
30–39	94,903	4,884	51.47	35.83
40–49	90,019	9,027	100.28	27.48
50–59	80,992	16,619	205.20	19.92
60–69	64,373	24,475	380.21	13.67
70–79	39,898	24,436	612.45	8.91
80–89	15,462	13,382	865.50	5.39
90–99	2,080	2,080	1000.00	2.37

* Because detailed population data for ages under ten were not available for the period 1805-1808, this abridged table begins with 100,000 children alive at age ten. Ordinarily it would begin with 100,000 infants at birth.

(Reproduced from Mortality in New York City a Century and a Quarter Ago, by Mary Dalton. Published in Human Biology, vol. vi, No. 1, 1934.)

age expectancy for individual years for each sex. Such life tables are indispensable for actuarial work such as life in-

surance, annuities and pensions. Abridged life tables, in which the average expectancy of life is shown by age groups, are frequently used by health administrators in making comparisons of health conditions. This use of a life table is shown on page 351, where a comparison is made of health conditions in New York City in 1805–1808 and in 1929–1931.

CHAPTER XLVIII

PUBLIC HEALTH WORK AN INVESTMENT

Efforts to save lives and to prevent or ameliorate human suffering always find a sympathetic reception by the public. One has but to think of the many philanthropic organizations engaged in health and social welfare activities to realize the extent to which this public altruism expresses itself in the form of substantial financial support.

The official public health administrator, however, usually finds it difficult and sometimes impossible to secure public funds for the work of his department, especially when some new activity is proposed. The fiscal authorities always point to the many other demands on the budget, they fear the votes of the taxpayers at the next election, and they silently contrast the apparently intangible benefits which the health officer holds out with such tangible ones as a new public library or post office, or a new fire engine, or a public park. To overcome the objections of the fiscal authorities the health officer will find it helpful to demonstrate that expenditures for well directed public health work constitute an investment *which pays excellent dividends in real money.*

In dealing with budget directors, city councilmen, members of the appropriations committee of legislatures and others it will be well to be as specific as possible. The following two examples taken from New York City's experience may be of service in showing the kind of information which can be presented:

Diphtheria.—In 1920 there were over 14,000 cases of diphtheria in New York City, of which 1045 ended in death. Approximately 3000 of the patients were treated in the city's contagious disease hospital, with an average stay of sixteen days. Because of the very special services necessary to prevent the spread of the disease to others, this hospital care costs the city about $7 per day. The 3000 hospitalized cases,

therefore, entailed an expense to the taxpayers of $336,000 during the year.

All the cases of diphtheria reported to the health department are promptly investigated by nurses. A check-up is made on the effectiveness of isolation, and cultures are made from the nose and throat of the patient and the other members of the household. If the patient is treated at home, additional throat and nose cultures are taken from the convalescent patient in order to determine when isolation may be discontinued. In New York City, experience shows that an average of six visits are made by nurses to patients treated at home and about two visits to patients subsequently treated in the isolation hospital. At the low rate of fifty cents, the 72,000 visits to 14,000 cases cost the taxpayers an additional $36,000 during the year.

On an average a little over ten nose and throat cultures for each reported case of diphtheria were examined in the health department's laboratory. All of these cultures were made on diagnostic outfits supplied by the laboratory, each outfit consisting of a tube of sterile solidified blood serum and a sterile swab. It is difficult to estimate the expense for this diagnostic laboratory service, but fifty cents per specimen is a conservative figure. The examination of ten cultures for each 14,000 cases of diphtheria burdened the taxpayer with an additional $70,000 during the year.

But not all the expense incurred by the prevalence of diphtheria was borne by the city treasury; a large part is always borne by the individual citizen in whose family a case of diphtheria develops, and who has a private physician treat the patient at home. Even though the health department supplies diphtheria antotoxin free of charge to those in the lower income groups, a most conservative estimate of the cost of medical care to the family having the patient treated at home would be $35. The 11,000 patients thus cared for in 1920 cost individual citizens a total of $385,000.

Furthermore there were the funeral costs of 1045 fatal cases in 1920. At the low estimate of $200 each, these amounted to over $200,000, practically all borne by the bereaved families.

Finally there is the monetary value of the lives needlessly sacrificed to diphtheria. From the careful studies of Dublin and Lotka, to which reference has already been made in Chapter VIII, the lives cut short by diphtheria represent a monetary value of not less than $5000 each. The economic loss caused by the 1045 diphtheria deaths in 1920 therefore amounted to over $5,000,000.

To return to our thesis, that expenditures for well directed public health work pay splendid dividends, let us see how the New York City Department of Health dealt with the situation.

During three years beginning January 1, 1929, with the aid of private funds, the Health Department carried on an intensive, well-organized educational campaign to secure the immunization of infants and young children against diphtheria. For three years approximately $125,000 a year was spent on this work, $75,000 of the total being supplied from private sources. At the end of three years the private funds ceased, and the money spent by the Health Department for the continuation of the educational work since that time has not exceeded $10,000 a year. What was accomplished?

In 1939 there were 543 cases and 22 deaths in New York City. Approximately half of the cases were hospitalized, the other half treated at home.

Following is a summary of the expense caused by diphtheria in 1920, and for comparison that caused in 1939:

Expenses Borne by the City Treasury, i. e., by the Taxpayer

	1920	1939
Hospitalization, $112 per case	$336,000	$31,000
Nurses' visits, 50 cents per visit	36,000	1,100
Laboratory work, $5.00 per case	70,000	2,750
Total borne by city treasury	$442,000	$34,850

Expenses Borne by Affected Families

Medical care, patient treated at home, $35	$385,000	$ 9,625
Funeral costs, $200 per death	200,000	4,400
Total borne by individual families	$585,000	$14,025

Economic Loss to the Community

Capital value of child lives lost, $5000 per life	$5,000,000	$110,000

This is an enormous financial return from an expenditure amounting to about $400,000 in eleven years. The city has more than recouped its outlay, the affected families have been spared an expense of well over half a million dollars, and the community has conserved a capital of nearly five million dollars.

Typhoid Fever.—A similar analysis can be made of the expense caused by typhoid fever. In 1920 there were 969 cases of typhoid fever in New York City, of which 137 ended fatally. Almost all of the patients were treated in hospitals. In 1939 there were only 198 cases and 22 deaths. The cost of this disease may be summarized as follows:

Expenses Borne by the City Treasury

	1920	1939
Hospitalization, $7.00 per day, 21 days*	$142,000	$29,000
Nurses' visits, $6.00 per case	5,400	1,200
Laboratory work, $10.00 per case	9,600	1,900
	$157,000	$32,100

Expense Borne by Affected Families

Medical care, patients treated at home*		
Funeral costs, $200 per death	$37,400	$ 4,400
	$ 37,400	$ 4,400

Economic Loss to the Community

Capital value of adult lives lost, $30,000 per life	$4,100,000	$660,000

* In typhoid fever not all of the patients are treated in municipal hospitals, but the cost, whether paid by the city, or borne in some cases by the patient's family, will be at least that stated for "hospitalization."

In this disease the nurses' visits, the laboratory work and the epidemiologic activities of the health department, carried on at a cost to the city treasury of a few thousand dollars, saves the people of the city many times this sum each year.

Other Examples.—In *pneumonia,* funds allotted to health departments in order to provide diagnostic laboratory services (typing stations) and a supply of type-specific therapeutic sera have also yielded handsome financial returns. This

is true also for activities in the field of *diabetes,* a disease in which the benefits are shown by the distinct prolongation of life of those receiving proper treatment. So too in the field of *accidental deaths,* expenditures for supervised playgrounds pay dividends in a reduction of injuries and deaths to children. Altogether we must constantly bear in mind the fact, so well expressed by Biggs:

"Public health is purchasable; within natural limitations a community can determine its own death rate."

INDEX

Accidents, 223
in industry, 280
Activated sludge, 248
Acromegaly, 212
Adrenals, disorders of, 212
African sleeping sickness, 161
Agglutinins, nature of, 39
Aging population, 194
Agramonte, yellow fever, 159
Air conditioning, 273
Air, health aspects of, 268
movement of, in ventilation, 271
Alastrim, modified smallpox, 133
Allergy, 219
Aluminum cooking utensils, 173
Amebic dysentery, 100
American Public Health Association, 317
Anatomy, Vesalius' work, 14
Anatoxin, diphtheria immunization, 111
Anesthesia, discovery of ether for, 25
Ankylostomiasis (hookworm), 178
Anopheles, life history of, 50
Anthracosis, 279
Anthrax, 128
Antibodies, important kinds, 36
Antiseptic surgery, introduction of, 24
Antiseptics, 62
Antitoxin for tetanus, 131
Antitoxins, discussion of, 36
Aqueducts in ancient Rome, 4
Armstrong, lymphocytic choriomeningitis, 169
Arsphenamine, discovery of, 63
Artesian well, 234
Artificial respiration, 225
Aschheim-Zondek test, 212
Ashe, protein in diets, 74
Aviation accidents, 230
Baby Health Stations, development of, 284
Bachman, skin test for trichiniasis 183
Bacteria in milk, 254
relation to disease, 32
Bacterial food poisoning, 174
vaccines, 41
Bacteriology, beginnings of, 22
Bacteriolysins, discussion of, 38
Balanced diets, importance of, 73
Bang's disease, 98
Banting and Best, insulin, 197
"B.C.G.," vaccine against tuberculosis, 85
Bedbugs, life history of, 57
Behring, diphtheria antitoxin, 109
Bends, the (caisson disease), 278
Benzol poisoning, 277
Beriberi, 189
Bible, sanitary laws in, 1
Biggs, motto coined by, 357
pioneer in health administration 24
Bill of health, in maritime quarantine, 312
Biological products, federal control of, 315
Birth injuries as factor in infant deaths, 289
Birth statistics, 341
Black death, quarantine against, 7
Blood, circulation of, 18
Botulism, food poisoning, 175
Bread from bleached roller mill flour 71
Brill's disease, 143
Brucellosis (undulant fever), 99
Burns and scalds, accidental, 226

Caisson disease, 278
Calcutta, Black Hole of, 268
Calmette, B.C.G. vaccine, 85
Calorie, definition of, 68
Cancer, 205
  industrial, 279
Carbon dioxide in ventilation, 269
Carbon monoxide, poisoning from, 277
Carbohydrates in nutrition, 69
Cardio-arterio-renal diseases, 203
Carriers in spread of disease, 47
Carroll, yellow fever, 159
Causes of death, accuracy on certificates, 345
Census, first mention of, 2
Cereals, whole grain, in diet, 71
Certified milk, 259
Chadwick, sanitary reform, 27
Chancroid (soft chancre), 154
Chapin, pioneer health administrator, 321
Chargin, intensive treatment of syphilis, 152
Chickenpox (varicella), 138
Child health stations, origin of, 284
Child hygiene, first division of, 284
Childbearing, health aspects of, 292
Child-bed fever, 126, 293
Chinchon, Countess of (Peruvian bark), 158
Cholera, 101
  infantum, 282
Cinchona bark in malaria, 19, 158
Cold storage of foods, 264
Common cold, 122
Communicable diseases, transmission of, 44
Complement in immunity reactions, 39
Confidential death certificate, 345
Contact beds for sewage disposal, 248
Contagia in Middle Ages, 6
Contagious abortion (Bang's disease), 98
Cooper, types of pneumococci, 118
Convalescents, serum of, 41
Cowpox (vaccinia), 133
Cretinism, 211
Cross connections, dangers of, 239
Cuban itch (alastrim), 133
Culex, life history of, 49
Cyanogen, poisoning by, 278
Cyclic recurrence in diseases, 336
  in diphtheria, 336
  in epidemic meningitis, 164
  in measles, 140
Cytolysins, nature of, 38

Death certificate, standard form, 344
  rates, age specific, 348
Deaths, economic loss caused by, 75
  of newborn by age and cause, 287
Deficiency diseases, 187–189
Dental caries, as health problem, 193
Diabetes mellitus, 186, 196
Diarrhea in infants, 282
Dick test, scarlet fever, 114
Diphtheria, cost to community, 353
  cyclic recurrence, 336
  historical, 104
  immunization against, 108
  prevalence and mortality, 105
  seasonal incidence, 326
Diphtheroids, 106
Diseases, reportable, 342
  seasonal incidence of, 326
Disinfection, discussion of, 61
Dog bites in rabies, 169
Dried milk, 260
Drinking water, purification of, 235
Drolet, tuberculosis case fatality, 86
Drowning, accidental, 224
Drugs, adulteration of, 261
Duffield, confidential birth certificate, 289
  death certificate, 345
Dusty trades, health hazards, 278
Dysentery, 100

Eaton, sanitary reform in U. S., 28
Eberth, typhoid bacillus, 91
Economic factors in public health, 78
Economo, lethargic encephalitis, 165

Edwards, case finding in tuberculosis, 88
Ehrlich, chemotherapy, 63
salvarsan (606), 151
Elephantiasis due to filaria, 184
Emerson, Haven, on health reorganization, 31
Encephalitis, acute infectious, 167
Endemic index, 333
Endocrine disturbances, 210
Epidemic meningitis, 163
seasonal incidence, 326
Epidemic typhus, 142
Epidemiologist, ideal type, 324
Epidemiology in public health, 324
Epizootic, definition, 165
Estrin, a gonad hormone, 213
Evaporated milk, 260
Exanthemata, 132
Expectation of life, 350

Farr, pioneer in vital statistics, 28
Fatigue in industrial hygiene, 279
Fats in nutrition, 68
Fecal excreta, disposal of, 242
Federal Security Agency, 310
Fetal deaths (stillbirths), 288
Filariasis, 183
Filth theory for communicable diseases, 21
Finlay, yellow fever, 159
Five-day treatment (syphilis), 152
Fleas, life history of, 55
Flies in transmission of disease, 46
life history of, 53
typhoid fever spread by, 95
Fomites in transmission of disease, 44
Food, handlers of, 264
intoxications, 175
poisoning, 172
Foods, adulteration of, 261
inspection of, 261
misbranding of, 262
preservation of, 263
Fracastor, theory of contagion, 13
Francis, tularemia, 129
Fraser and Halpern, diphtheria, 106

Galen, Greek physician, 8
Garbage, hogs, and trichiniasis, 182
sanitary disposal of, 251
Gas poisoning, accidental, 228
Gastric juice, defense against germs, 35
Gerhard, pathology of typhus and typhoid, 91
Germicides, 62
Gigantism, 212
Glycosuria in diabetes, 186, 197
Goiter, 211
Gonadotropic hormones, 212
Gonads, hormones of, 213
Gonorrhea, 153
Gorgas, overcrowding and pneumonia, 119
portrait of, 161
Graunt, pioneer in vital statistics, 18
Greece, ancient sanatoria, 3
Grotjahn, pioneer in social hygiene, 30
Ground water, 232

Halley, first life table, 18
Harvey, circulation of blood, 15, 18
Hay fever, 219
Hebrews, health laws of, 1
Health administration, federal, 308
reorganization of, 310
local, 321
state, 317
education, general discussion, 305
New York City, 30
school children, 299
expenditures, an investment, 353
insurance, proposal for, 31
problems, changing, 191
Heart disease, 202
Heat exhaustion, 274
occupational hazard, 279
stroke, 274
Hemamebae in malaria, 156
Hemolysins, nature of, 38
Heredity in diabetes, 198
Hess, Julius, rearing premature infants, 289

Hippocrates, "Father of Medicine," 2
Hookworm, 178
Hospitals, origin of, 11
  reform of, 27
Humidity, factor in ventilation, 270
Hydrophobia (rabies), 169

Illegitimacy and infant mortality, 292
Illness, economic loss from, 75, 353
Illumination, health aspects, 267
Imhoff tank for sewage digestion, 246
Immigration, health supervision of, 314
Immunity, natural and acquired, 34
Incineration for rubbish and garbage, 251
Incubation period, certain common diseases, 330
  nature of, 33
Industrial hygiene, 275
  poisonings, 276
Infant hygiene, 281
  mortality among Negroes, 78, 291
    analysis of causes, 285
    by age, 287
    by family income, 78
    New York City, 281
    26 American cities, 291
Infantile diarrhea, 282
  paralysis, 165
Infantilism, endocrine disorder, 213
Influenza, characteristics of epidemics, 121
  nature and prevalence, 119
Injury at birth, 289
Insanity (mental disease), 215
Insects as vectors of disease, 47
  life history of certain, 49
Insolation (sunstroke), 274
Insulin in prolongation of life of diabetics, 198
Intelligence tests, 298

Japanese river fever, 144
Jenner, smallpox vaccination, 20
Jews, cancer in, 206
  diabetes among, 198
  persecution of, 9

Kata thermometer in ventilation 271
Kay-Graham phosphatase test 260
Kircher, early microscopist, 17
Klebs, diphtheria bacillus, 105
  pioneer bacteriologist, 23
Koch, beginnings of bacteriology 22
  cholera spirillum, 101

Laboratory, first public bacteriologic diagnostic, 24
Laudable pus, 127
Laveran, malaria parasites, 156
Lazear, martyr to yellow fever, 159
Lead poisoning, 276
Leeuwenhoek, first microscopes, 17
Leprosy in Europe, control, 5, 7
Leukocytes, defense against germs 35
Lice, life history of, 58
Life, capital value of human life, 76
  tables, first one compiled, 18
    general discussion, 350
Lind, observations on scurvy, 29
Lister, antiseptic surgery, 24
  wound infections, 126
Littauer, diabetes association, 201
Lobar pneumonia, seasonal incidence, 326
Local health administration, 321
    per capita cost, 323
Lockjaw (tetanus), 130
Löffler, diphtheria bacillus, 105
Long, first use of ether in surgery 25
Lues (syphilis), 146
Lymphocytic choriomeningitis, 169
Lymphogranuloma, 154

Maggots in fly-breeding, 53
Malaria, control of, 158
history, etiology, 155
introduction of cinchona bark, 19
seasonal incidence, 326
Malignant pustule, 128
Malnutrition, 185
Malta fever, 98
Mantoux test in tuberculosis, 84
Maps, use of, in epidemiology, 327
Maternal mortality, 292
Measles (rubeola), 139
seasonal incidence, 326
Meat inspection, 261
Medical care, cost of, 75
Meningitis, epidemic, 163
Menstruation, hormones in, 212–213
Mental deficiency, 217
diseases (psychoses), 215
Metchnikoff, phagocytosis, 35
Mice in lymphocytic choriomeningitis, 169
Micro-organisms, relation to disease, 32
Microscopes, earliest, 17
Middle Ages, medicine and surgery in, 7–10
Midwives, supervision of, 295
Milk, bacteria in, source of, 254
grading of, 258
in transmission of disease, 45
pasteurization of, 256
relation to infant diarrhea, 282
supply, administrative control of, 253
Minerals in nutrition, 70
Miners' anemia (hookworm), 178
Mining, accidents associated with, 230
Missed cases as spreaders of disease, 48
Mites in tsutsugamushi disease, 144
Montagu, smallpox inoculation, 20
Morbidity statistics, 342
Mortality statistics, 343
Mosaic Code, 1
Mosenthal, protein in diets, 74
Mosquitoes in filariasis, 184
in malaria, 156
Mosquitoes in yellow fever, 159
life history of, 49
Murchison, filth theory of disease, 21
Murine typhus, 142
Mussel poisoning, 173
Myxedema, 211

Neisser, germ of gonorrhea, 153
Negri bodies in rabies, 170
Negroes, infant mortality among, 78, 291
Neonatal mortality, analysis of, 285
Neufeld test for pneumococci, 118
New York Diabetes Association, 201
Newsholme, health administration, 28
Nightingale, hospital reform, 27
Normalized average in endemic index, 334
Nursing, public health, 300
Nutrition, disorders of, 185
principles of, 67

Obesity, 185
Occupational disease, 16, 275
Offal, disposal of, 251
Olesen, pathometer, 337

Paracelsus, iconoclast and pioneer, 9, 16
Paratyphoid fever, 98
Paré, Father of Surgery, 10
Park and Holt, studies on infant diarrhea, 282
Park, diphtheria immunization, 111
pioneer American bacteriologist, 24
portrait of, 283
Parrots, spreaders of psittacosis, 124
Pasteur, studies on fermentation, 22
vaccine in rabies, 169
Pasteurization of milk supplies, 256
Pathometer in epidemiology, 337
Pellagra, 188
Pertussis, 123
Pest (bubonic plague), 128
Pfeiffer, influenza bacillus, 120

Phagocytosis, defense against germs, 36
Phosphatase test for pasteurization, 259
Phosphorus poisoning, 277
Physical defects in school children, 296
Pituitary, disorders of, 212
Plague (black death), 7, 128
Plasmodium of malaria, 156
Plumbing, health aspects of, 239
Pneumonia, economic loss by death, 76
  nature of, 116
Pneumococci, types of, 118
Poisons, industrial, 276
Poliomyelitis (infantile paralysis), 165
Pollens in hay fever, 219
Population, age distribution of, 194
  statistics, 339
Pork in trichiniasis, 182
Poverty, relation to public health, 79
Pratique in quarantine, 312
Pregnancy, Aschheim-Zondek test for, 212
  in diabetes, 199
Prematurity, a factor in neonatal deaths, 289
Prenatal work, 294
Preventive medicine, definition, 2
Privies for sanitary disposal, 242
Progestin, gonad hormone, 213
Prolan, gonadotropic hormone, 212
Proteins in nutrition, 69
Protozoa, relation to disease, 32
Psittacosis (parrot disease), 124
Ptomaine poisoning, 174
Public health nursing, 300
Public Health Service, activities of, 311–316
Pure Food Law, 261
Puerperal infection, 293

Quarantine, interstate, 313
  maritime (U. S.), 311
  origin of, 7
Quinine in malaria, 158

Rabbits, tularemia, 129
Rabies, 169
Rachitis (rickets), 187
Ramon, anatoxin, 111
Rats in plague, 128
Ravenel, bovine tuberculosis and human infections, 90
Reed, yellow fever, 159
Refrigeration of foods, 264
Renaissance in medicine, 12
Reportable diseases, 342
Rhazes, Arabian physician, 12
Rheumatic heart disease, 202
Rickets, 187
Roaches, life history of, 60
Rocky Mountain spotted fever, 143
Rome, sanitary engineering in, 3
Ross, transmission of malaria, 155
Rubbish, disposal of, 251
Rubeola (measles), 139

Salmonella in food poisoning ,174
Sanctorius, an early physiologist, 15
Sand filters, 235
Sanitary land fills, 252
  reform in England, 27
    in United States, 28
Scarlet fever, 113
Scharer, phosphatase test, 260
Schaudinn, germ of syphilis, 148
Schick test for diphtheria immunity, 107
School children, medical supervision of, 296
Schultz-Charlton phenomenon, 115
Scurvy, 187
Seasonal incidence of disease, 326
Septic infections, 125
  sore throat, 113
  tank for sewage disposal, 247
Serum therapy, general discussion of, 41
Sewage disposal, 242
Silicosis, 279
Simon, sanitary reform in England, 27
Skin, unbroken, protection by, 35
Sleeping sickness, African, 161

Sleeping sickness, encephalitis, 168
Smallpox (variola), 132
  inoculation against, 20
  vaccination against, 135
    introduction of, 20
Social hygiene, Grotjahn's work, 30
Specific death rates, New York City, 348
Spotted fever (epidemic typhus), 142
    (epidemic meningitis), 163
Springs as water supplies, 235
Standardizing death rates, 349
Staphylococcus in food poisoning, 176
State health administration, 317
Stokes, martyr to yellow fever, 159
Stouman, deaths of premature infants, 289
Straus, Nathan, portrait of, 284
Streptococcus in septic sore throat, 113
Strusser, public health dentistry, 193
Sulfapyridine in pneumonia, 119
Sulfonamides, 64
  in pneumonia, 118
  in venereal diseases, 154
Sulfathiazole in pneumonia, 119
Sunlight, health aspects, 266
Sunstroke, 274
Suprarenals, disorders of, 212
Surgery, beginnings of, 10
  introduction of antisepsis, 24
Syphilis (lues), 146
  first use of term, 14

Tetanus (lockjaw), 130
Theelin, a gonad hormone, 213
Thyroid, disorders of, 210
Ticks in Rocky Mountain spotted fever, 144
  life history of, 57
Toxoid for diphtheria immunization, 111
Trench fever, 144
Treponema pallidum, 147
Trichiniasis, 181
Trickling beds for sewage disposal, 248
Trypanosomiasis (sleeping sickness), 161
Tsetse flies, life history of, 55
Tsutsugamushi disease, 144
Tuberculin in diagnosis, 84
Tuberculosis and milk supply, 89
  case finding methods, 88
  causative factors, 81
  control measures, 87
  immunization against, 85
  nature and prevalence, 80
  relation to age, 82
Tularemia (rabbit disease), 129
Typhoid carriers, 97
  fever, control by water filtration, 93
    control measures, 96
    cost to community, 356
    fly-borne, 95
    nature and prevalence, 91
    seasonal incidence, 326
    Widal reaction, 40
Typhus, varieties, 141

Undulant fever, 98

Vaccination, introduction of, 20
  types of reaction, 137
Vaccine therapy, general discussion of, 41
Vaccinia (cowpox), 133
Varicella (chickenpox), 138
Variola (smallpox), 132
Vasomotor rhinitis, a form of allergy, 221
Ventilation, health aspects of, 268
Vesalius, founder of anatomy, 14
Virus of encephalitis, 165
  of equine encephalomyelitis, 165
  of influenza, 120
  of measles, 140
  of poliomyelitis, 165
  of psittacosis, 123
  of rabies, 169
  of yellow fever, 160
Visiting-nurse services, 300
Vital statistics, definition, 339

Vital statistics, discussion, 339–353
early, 18
pioneers in, 28
Vitamins in deficiency diseases, 187–189
in nutrition, 71

Wallgren, lymphocytic choriomeningitis. 169
Wassermann, 148, 151
Water closets and sewerage systems, 244
supply, 231
Wells, shallow and deep, 234
Weichselbaum, meningococcus, 163
Weil-Felix test in typhus, 143
Wheat flour, stone ground and roller mill, 71
Whooping cough, 123
Widal reaction, specificity of, 40
Wilbur, Cressy, 317
Woolsorters disease, 128, 278
Wound infection, 126

x-Ray in tuberculosis case finding, 88

Yellow fever, nature of, 159
Young, martyr to yellow fever, 159

Zinsser, typhus, 143

DATE DUE

RETURNED
MAY 3 1972

DEMCO 38-297

YOUNGSTOWN STATE UNIVERSITY
3 1217 00497 7511

RA
425
.B72
1941

Bolduan, C. F.

39699

JUL 22 1970

YOUNGSTOWN STATE UNIVERSITY
LIBRARY